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MARINE ENGINEERING.

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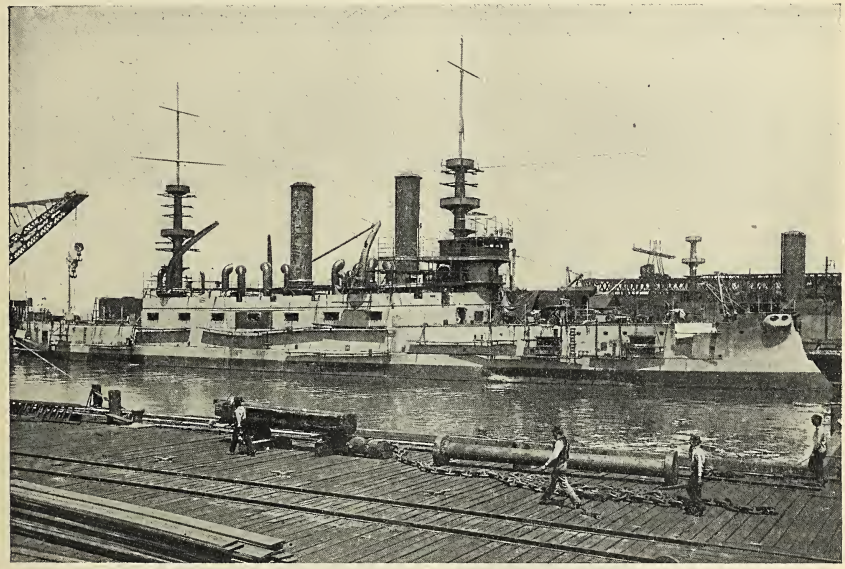
U. S. BATTLESHIP KEARSARGE NEARING COMPLETION AT NEWPORT NEWS SHIPYARD.

The appearance of a battleship when nearing completion at the builders is well illustrated in the photograph of the U. S. S. *Kearsarge*, taken recently at Newport News and here reproduced. The construction of this fine vessel together with her sister ship the *Kentucky* was authorized by act of Congress of March 2, 1895, and the contract for her construction was signed January 2, 1896. Both the *Kearsarge* and the *Kentucky* were launched on the same day, March 24, 1898. The *Kearsarge* is a vessel of 11,525 tons displacement and is of these dimensions: length, 368 ft ; beam, 72 1-2 in. and draught, 23 ft. 6 in. She is fitted with twin screws driven by triple expansion engines of 10,000 I. H. P., designed to give a sea speed, with forced draft, of 16 knots. Her boilers are five in number, three double ended and two single ended, of the Scotch type. They are 15 ft. 6 1-2 in. outside dia. and about 10 ft. and 20 ft. long respectively. The shells are of 1 7-16 in. steel plate, and the working pressure is 180 lbs. Forced draft on the closed fire room system is fitted. There are two smoke pipes, as will be noticed in the photograph, spaced widely apart in a fore and aft direction. Her design calls for an armament of four 12-in. and four 8-in. breech loaders carried in pairs in double turrets, the small guns being superimposed on the larger. In addition there will be fourteen 5-in. rapid fire guns in the central battery, and the smaller guns will include twenty 6-pdr. and six 1-pdr. rapid fire guns, four Colt automatic guns and two 3-in. field guns. Four torpedo tubes will be fitted. The armor will be Harveyized steel, ranging in thickness from 17 in. in the turrets downward to 9 in., according to the location.



U. S. S. KEARSARGE LYING AT THE BUILDERS' WHARF—ONLY 13-IN. TURRETS IN PLACE.

(Copyright, 1899, by Aldrich & Donaldson, New York.)

New Ships for International Navigation Company.

Particulars of the six new steamships under construction for the International Navigation Company are of interest. Four of these vessels are building at Clydebank, Scotland—two for the Red Star Line and two for the American Line. The remaining two are to be built by William Cramp & Sons, Philadelphia.

The vessels to be built by Cramps will be sister ships to the vessels under construction at Clydebank for the Red Star Line.

The Red Star Line vessels under construction at Clydebank will be named *Vaderland* and *Zeeland,* and will be of the following dimensions: Length, 560 ft.; beam, 60 ft.; depth, 42 ft.; measurement, about 12,000 tons, and displacement, 20,000 tons. They will be fitted with twin-screws and bilge keels, and will have accommodations for 300 saloon, 250 intermediate and 750 steerage passengers. The two classes of cabin passengers will be carried amidships in a bridge deck-house, and there will be a limited number of suites provided for saloon passengers. The main dining saloon will be large enough to accommodate all the first-class passengers at one sitting, and the usual comforts and conveniences, such as library, smoking rooms and lavatories, will be provided. The state-rooms will be large, and special attention will be given to their ventilation, so that even in rough weather, when all the doors are closed, there will be an abundance of fresh air in the living quarters.

The second cabin accommodations will be unusually comfortable, in that they will be situated in the deck-house, and most of the rooms will be really deck cabins. For the accommodation of this class of passengers there will be a large amount of promenade deck space and comfortable smoking rooms, and a social hall in addition to the dining saloon. The steerage accommodations will be strictly up to date. These passengers will be berthed in two, four and six berth rooms, well lighted and ventilated, with extensive lavatories and bath accommodations, and for their recreation there will be well sheltered deck space and a large social hall.

These vessels will be fitted with a moderate amount of power, so that they will be able to make the trip from New York to Antwerp, about 3,300 nautical miles, in eight days, which gives a steaming rate of about 17 knots.

The two vessels building at Clydebank for the American Line will be named *Merion* and *Haverford,* and they will be put on the Philadelphia-Liverpool route. They will be of the following dimensions: Length, 530 ft.; beam, 59 ft.; depth, 39 ft.; measurement, about 10,000 tons. These vessels will be of the intermediate type, with a large cargo carrying capacity and a sea speed of 13 knots.

Following the custom of the Philadelphia service of the American Line, there will be accommodations for only one class of cabin passengers—saloon. To the number of 130 they will be provided for in the deck-house amidships. The accommodations will be strictly modern in every respect, though undoubtedly the fares will be rather lower than are charged on the fast ships. There will be accommodations for about 800 steerage passengers. The steamships now on this service are the *Belgenland,* 3,692 gross tons, built at Barrow, and the *Pennland,* 3,760 gross tons, built at Glasgow.

MARINE GROWTHS—AN EFFECTIVE ARGUMENT FOR THE BUILDING OF DRY DOCKS.

BY COMMANDER H. WEBSTER, U. S. N.

The experience of those who go to sea in ships is that many parts of the ocean are filled with the eggs and embryos of numberless types of animal and vegetable life, and it is against the injury done by these so-called "marine growths" that the ingenuity and chemistry of shipbuilders and ship owners are in constant activity.

Tropical waters are teeming with animal and vegetable life, and this is especially true of those coasts where the tides are small and the sea currents feeble and infrequent.

Without going into the scientific names of the various growths, it is enough to say that the teredo, or ship borer, the barnacle, sponges, oysters, coral formations and grasses form an aggregation ever ready to pounce upon and adhere to any solid presented.

Many of these formations are classed as on the debatable line between the animal and the vegetable kingdoms, some of the growths in Honolulu being described as a "shell-less oyster without any meat."

It is a common error to assume that a coppered bottom does not become foul, for after a longer or shorter period the copper surface becomes covered with a film of a neutral nature, and upon this film all the marine growths noted adhere and flourish about as luxuriantly as where no copper exists.

The reason for this can be readily understood when the process whereby copper acts when submerged is understood. Copper in sea water is feebly acted on by the free sulphuric acid held in solution, and a minute quantity of copper sulphate is formed. From this arises the faint green tint noticed on the bottom of a coppered ship. This copper sulphate is poisonous to all marine growths save a few of very low order, so that the germs, which in innumerable multitudes are constantly seeking a resting place, are either killed or sickened, and so the surface remains clean, or nearly so. Besides this poisonous action of the copper sulphate it has also an exfoliating action, and by the motion of the waves, assisted by the speed of the ship, thin flakes or films are continually becoming detached from the sheets of copper, carrying with them, of course, any adherent animal or vegetable matter.

But in course of time this formation of copper sulphate decreases in quantity, and the surfaces slowly but surely become coated with a black substance, formed partly from the copper and partly due to the gradual accumulation of life forms not affected by the films of copper sulphate. As soon as this takes place and the surfaces become innocuous, marine growths, both animal and vegetable, will flourish as readily and luxuriantly as upon any other submerged surface, and the coppered ship needs docking and cleaning as much as her painted bottomed sister.

This process in the decline of protective power is exceedingly slow, however, and whereas the painted bottom becomes foul in a few months, sometimes weeks, the coppered bottom will remain clean and serviceable for three or four years, depending, as in the other case, upon the waters visited.

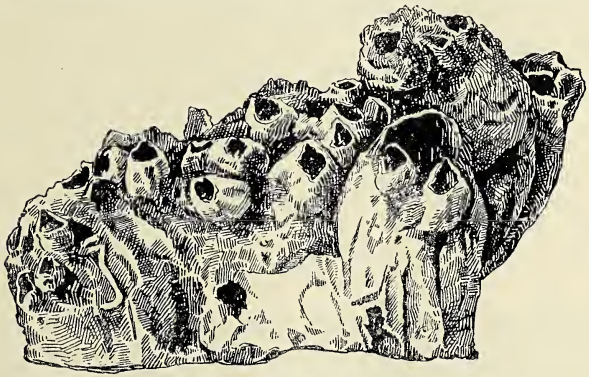
The methods employed for the removal of barnacles and grass are not various, consisting in going from salt water to fresh, in scraping the bottom by divers and by scraping the bottom while the ship is in dry dock.

The first method is only efficacious in the removal of vegetable growths, for while the animal life is speedily killed by the fresh water, the shells and envelopes with which these animals are protected remain, giving a firm foundation for new growths as soon as the ship resumes her cruise at sea.

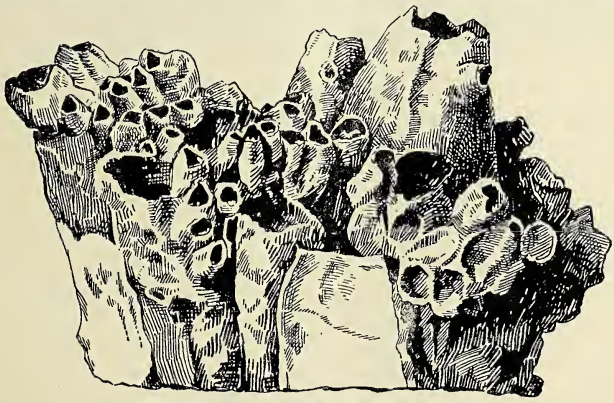
So far from the sea-growths being injurious to the bottom of a metal ship, they afford not a little protection to the steel or iron, and where the bottom is thickly coated with barnacles no injury is likely from the usual influences, and if the ship is lightly grounded the envelope of marine growths has been known to have been a sensible protection from injury.

From the foregoing it will be understood how complicated and difficult is the problem with which the shipbuilder in confronted.

First, he must protect the ship's bottom; next, he must not cover it with a substance to which marine life can adhere without injury, for then the ship's speed and efficiency begins to suffer as soon as the voyage commences. Neither must he apply a substance which, while detrimental to life be also injurious to the ship's material. And so the puzzle grows, until the ingenuity of the chemist, the metallurgist and the sailor have evolved the various paints, coatings and protectors with which the navigator is tempted to defy the elements, animate and inanimate, found in every sea.



BARNACLES REMOVED FROM SHIP'S BOTTOM—FULL SIZE.



BARNACLES REMOVED FROM SHIP'S BOTTOM—FULL SIZE.

Every variety of paint tried thus far fails to protect, though some retard the evil more than others; but the inevitable arrives, and the difference is one of time alone and is not very great. Other conditions being equal, the warmer the water the more rapid the fouling.

As regards iron, the product of its corrosion in sea

water adheres strongly to its metallic base and seldom, or never, falls off, and whatever marine growths attach themselves to it remain and grow, receiving ever increasing accretions until the mass, if not removed, increases to inches in thickness, the sea moss thickly filling up the interstices. The same result happens to the painted surface if the paint remains unbroken, and, as indicated above, continues a long time when protected by the covering of marine animals and plants already described.

In the solution of the problem, therefore, it is necessary to make a choice of two evils, one of which is of the most pressing nature, while the other evil is so far removed from the first that it must be regarded as almost no evil at all.

The method which has been found by experience to offer almost complete immunity from fouling to either iron or steel ships is that of sheathing the ship's bottom with wood and then coppering it.

The custom of sheathing is of very ancient date, and is found in vogue in China and Japan at the present time, having been brought down from time immemorial. The bottoms of those curious craft known to us as junks are constructed of wood, but their bottoms are not protected by a metal covering. Instead of which they are coated with pitch which, in turn, is sheathed over with thin boards or planking as a protection for the submerged portion of the hull. This sheathing is renewed at intervals, with the result that one of these junks has been known to remain in seaworthy condition for a century.

The process of sheathing a modern warship is one of the most difficult tasks set for the Naval Constructor. The metal bottom of the ship to be sheathed must be so prepared that it is completely insulated from the copper with which the wooden sheathing is covered, and this wood planking must be so secured to the ship that no reasonable amount of strain shall dislodge or rupture the continuity of the sheathing.

As a matter of fact, in the British Navy, the space remaining between the wooden envelope and the iron or steel bottom of the ship is filled with liquid red lead forced in by powerful pumps until a complete film of this substance is interposed between the wood and the metal.

Notwithstanding the care and expense this process entails, incidents occur when it becomes inefficient and the ship is in even a worse condition than if no sheathing had been attempted.

The British corvette *Calliope* is a case in point. During the hurricane at Samoa, in March, 1889, this ship, in common with those of the United States and Germany, was buffeted by wind and sea almost to destruction, and it was found that the wooden sheathing had become so much strained by the incidents of the hurricane that before necessary repairs could be made the underwater part of the hull was so corroded and injured that a large expense was necessary to retain the ship in the active list.

Although cleaning a ship's bottom can only be properly done in a dry dock, and must be attended to as often as once in six months, the operation of docking is an expensive one, as well as dangerous.

In government docks the sole expense is that of labor to prepare the dock for use and take the ship in and out. For a vessel of 4,000 tons or under, this amounts to about $400; but to this sum must be added the scraping and painting, say a thousand dollars more, or a total of not far from $1,400, and this, too, must be incurred on an average twice a year.

It is something quite different when a private dock is employed. A few years ago a French ironclad was docked, scraped and painted at San Francisco, and the bill amounted to $15,000.

One of the many puzzling things connected with "those who go down to the sea in ships," is that the larger the ship the higher are the charges, notwithstanding the fact that in the given dock the amount of water to be pumped out is less as the ship's displacement increases.

As soon as the ship enters the dock the responsibility of the dockmaster begins, and as the water begins to fall and the ship takes the blocks the process of scraping the bottom as it emerges from the water begins. By the time the water is out of the dock the ship's bottom is clean, and the mass of marine life lying in the dock almost surpasses belief.

During the cruise of the U. S. S. *Alert* on the China station the ship was docked and cleaned at Hong-Kong, and not less than thirteen tons of barnacles, coral and vegetable marine growth were removed.

Barnacles four inches long, sea grasses six feet in length, pieces of sponge six inches in diameter, coral growths covering square feet in area, are a few of the singular objects found on a ship's bottom whenever she is docked for cleaning and painting.

A barnacle has been not inaptly described by Huxley as "a crustacean fixed by its head and kicking the food into its mouth with its legs." The technical name of the barnacle is *Lepas anatifera*. The Teredo, *Teredo navalis*, or borer, is a worm-shaped, grayish-white animal, noted for its destructive habits in boring into submerged timber. It has very long united siphons, and thus looks like a worm, and varies in length from a few inches to three feet. These marine growths are of almost universal distribution, extending from 74 north latitude to Cape Horn. Marine animal life is largely a matter of temperature, the warmer the waters the more rapid the growth.

The accompanying photograph shows the growth on the bottom of the U. S. S. *Bennington*, while on the Pacific coast of Guatemala for but sixty-three days. Its companion illustrates the appearance of the bottom after being scraped and painted at the Mare Island Navy Yard in 1894.

The difference in friction between a copper bottom and a painted iron skin has an important bearing on the question of speed, and the result of experiment gives the following figures:

Surface.	Resistance Coefficient.
Clean copper	.007
Smooth paint on iron or steel hull	.010
Iron or steel skin	.014

From which it appears that the friction of an iron or steel skin is twice that of a smooth copper bottom.

W. H. White, the well-known British Naval Constructor, writes as follows on this branch of the subject:

A third deduction is the great increase (of friction) which results from a very slight difference in the apparent roughness of the surface.

Frictional resistance is the most important element of the total resistance of most ships and in well-formed ships moving at moderate speed it constitutes nearly the whole of the resistance.

As a general result, the resistance of a well-painted iron or steel bottom will average, for an exposure of three months to sea-water, an increase of 50 per cent, involving a loss of about one-seventh of the speed. For example, a vessel that makes fourteen knots per hour with clean bottom will average only twelve knots during the three months.

If at the commencement of the three months the resistance be taken as one, then at the end of the three months it will be represented by two, and the loss of speed at the end of the three months will be about one-fourth; that is to say, the fourteen knots will have fallen to ten knots.

B. F. Isherwood, late Engineer-in-Chief, U. S. N., has the following to say in this connection:

The only method known whereby this disastrous loss of speed can be prevented is to sheathe the bottom of the iron vessel to a certain height above water with wood, and to copper the sheathing; and this method must be adopted for naval cruisers.

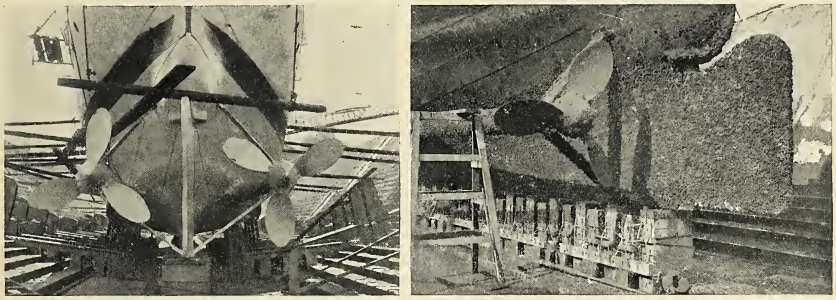
Of course, the final argument in the question makes its weight felt in the coal bunker, for if the speed of the ship is reduced by a foul bottom the quantity of coal required to steam a stated distance will vary in inverse ratio.

A notable illustration of this occurred last year in the inability of the Spanish fleet under Admiral Cervera to steam at anything like its normal speed owing to the condition of the bottoms of the vessels composing that fleet.

The fact that a vessel may be almost constantly under way seems to have but little influence on the underwater conditions, these marine growths being so minute in their earlier stages that the friction of the water passing the moving ship has no appreciable effect on the "spat" so freely distributed by nature.

Tropical waters, especially, teem with animal and vegetable life, and the conditions here are such that at no time are their activities modified. Once a barnacle, or, indeed, any form of marine life, effects a lodgment on a ship's bottom nothing short of actual mechanical force will dislodge it. In spite of speed, in spite of change of temperature, in spite of everything except scraping, the tiny speck of life grows, strengthens and adds to its resistance, until it affords protection for other forms of obstruction, and so the process goes on until in the language of the sailor "the ship can't get out of her own way," and docking becomes the only path away from disaster.

It may be asked why a ship cannot be cleaned more or less thoroughly while still afloat and on her station, either by mechanical devices or with divers. As a matter of fact, this is quite practicable, but as has been said, these marine growths cling with such tenacity that in removing them the film of paint to which they adhere is also removed in the operation, and the naked metal of the ship becomes exposed to the corrosive action of the sea water, and the last state of that ship is likely to be worse than the first. Consequently a stringent prohibition exists against cleaning a ship's bottom except while in dock, when the removed paint can be at once replaced.



STERN VIEW OF WAR VESSEL BEFORE AND AFTER SCRAPING IN DOCK.

It has been said that the measure of a nation's naval strength is gauged by the number of docks it can control, for thereby its efficiency and supremacy are maintained in time of war, and the security enjoyed by that country whose ships are sure of docking facilities all over the world forms one of the strongest arguments for this form of governmental expenditure.

The distribution of the dry docks of the world and the countries controlling them or owning them is as follows, and is approximately correct:

Great Britain, of course, stands at the head of the list with no less than 343 docks, of which it absolutely owns forty-two. The United States follows with a total of but sixty, six being of government ownership. France owns thirty-two, the other maritime and naval nations following in this order: Italy, eight; Germany, eight; Spain, seven; Sweden, six; Austria, Belgium, Denmark, Holland, Japan, Chili and Brazil with two each.

The foregoing list is probably not strictly accurate, it being compiled from information gathered several years since, but it is sufficiently correct for purposes of comparison.

The old adage that "it is never too late to mend" finds its application, in this connection, in the disposition shown by the last Congress to increase the number of government dry docks to something approaching the necessities of our navy, and a good beginning is thus being made toward the formation and maintenance of a fleet which shall be regarded as in some sort an exponent of the commanding position the nation is taking in the world by sheer force of wealth and population.

The events of the year just drawing to a close have emphasized in a manner understood of all the reasons for a navy, and the practical-minded American feels that whatever we need we must have, and that of the best. And having, in many respects, the best ships in the world, it is imperative that they be maintained at the high standard of efficiency for which they have always been noted.

The record made by the sheathed (composite) ships of our navy since their completion should be sufficient to convince the most skeptical of the wisdom of adding whatever of expense is entailed by the system for the sake of the improved efficiency of the ships, as units, and of the navy as a whole.

But while we are building dry docks let us not drop back into the "penny wise but pound foolish" ideas of the advocates of wooden docks, whose life is measured by that of the weeds and grass which flourish on the decay of their fabric.

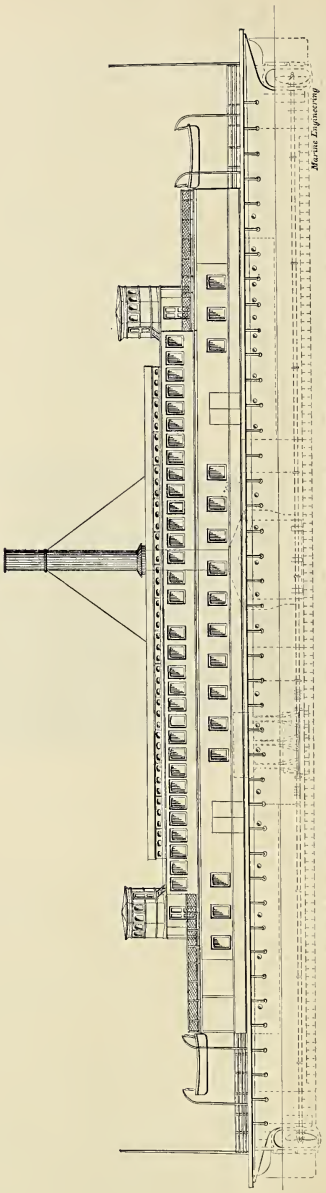
Therefore, sheathed ships, stone dry docks, coaling stations, should be regarded as the component parts of an harmonious whole whereby the phrase "United States Navy" should stand for all that is defensive, offensive, protective and efficient.

PROPELLER FERRYBOAT BERKELEY IN SERVICE IN SAN FRANCISCO BAY.

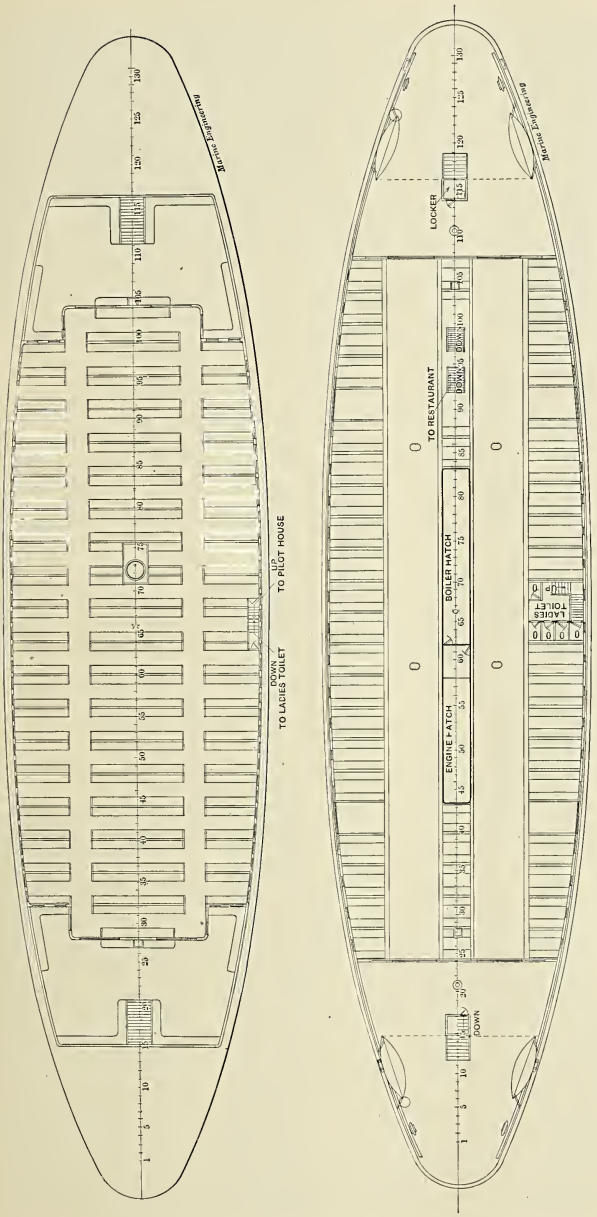
Photographs of the ferryboat *Berkeley* show the first *propeller* ferryboat put in service on the waters of San Francisco Bay. As is well known the ferry service between San Francisco and Oakland, California, has been for a number of years unexcelled the world over in point of size and appointment of the ferryboats. The vessels used have hitherto all been paddle steamers, fitted with side wheels with radial floats. When the construction of the *Berkeley* was decided upon the manner of propulsion was very carefully discussed, and after many consultations it was decided to build a boat with one set of engines and one line of shafting, running from end to end, with a single propeller at each end, instead of twin screws, such as are used in the ferry service on the North river, New York.

The *Berkeley* has a steel hull, measuring 289 ft. over all, 260 ft. on the water line, 40 ft. moulded beam, 64 ft. beam over the guards, 16 ft. 6 in. depth, and a tonnage of 1,245 tons.

The keel was laid on January 25, 1898; the boat was launched on October 18, 1898, and completed November 6, 1898. The christening ceremony was very pleasing on account of the interest taken in the vessel by the good people of the borough of Berkeley, who presented the vessel with a suit of flags, in honor of the boat being named for their town. The boat was launched from the yard of the Union Iron Works by



PROFILE OF DOUBLE SCREW FERRYBOAT BERKELEY, IN SERVICE BETWEEN SAN FRANCISCO AND OAKLAND, CAL.



PLANS OF THE DOUBLE SCREW FERRYBOAT BERKELEY BUILT AND ENGINED BY THE UNION IRON WORKS, SAN FRANCISCO, CAL.

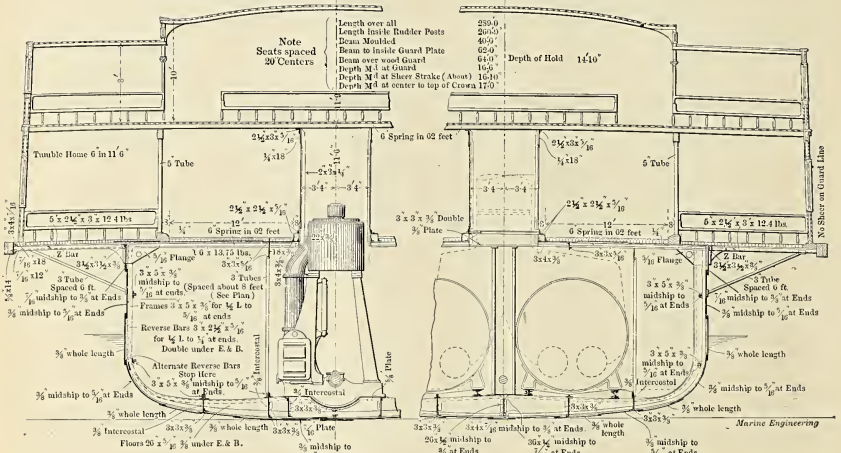
Miss Marion Huntington, of San Francisco, and christened by Miss Ruby Richards, of Berkeley, while the flags were raised to the breeze by the children of prominent residents of Berkeley.

The *Berkeley* has a total seating capacity for 1,750 passengers. The framing for the seats is all made of teak wood, while the seats themselves are made of perforated wood. The upper cabin extends to the almost extreme ends of the upper deck, completely enclosed in plain glass; and running around the top of the cabin is a narrow strip of handsome ornamental colored glass. The cabin is free from all obstructions, with the exception of the small casing, which allows the smoke pipe to pass up through the top of the house, and a sufficient number of small stanchions to prevent vibration of the arched roof.

One other subject that attracts a good deal of attention and is a novelty as applied to ferryboats is the means of ventilation in this cabin. The columns at the sides and at the ends of the seats are all made of gas pipe, with a register at the upper end in the ornamental work, while the lower end connects with the air trunks made of steel. They pass underneath the upper deck and thus serve the double purpose of air trunks and supports to the upper deck. Below in the engine-room there is placed a ventilating fan, run by an independent compound engine, which takes its suction from the outside, delivering fresh air throughout the boat, the supply being controlled by the registers. In the winter time, in wet weather, or when it is cold, this fresh air is passed over a coil of steam pipe, and heated to any degree that may be required, before it is discharged into the cabin. This means of ventilation although creating some doubt as to its efficiency when adopted, has proved by service that it was not a mistake, and has met with general approbation.

The pilot houses are at either end, in the usual manner. The vessel is provided with steam steering gear, of the three cylinder engine type, as made by the Union Iron Works, having an engine on the main deck, directly beneath each pilot house, and connected with the rudders at the opposite ends of the vessel.

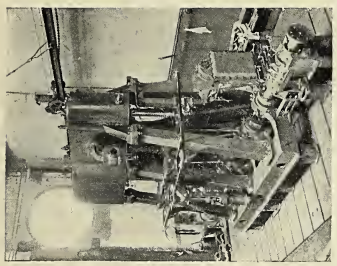
The stairways from the main deck to the upper deck are somewhat different from most ferryboats, having been placed in the middle of the deck, one at either end, facing the ends of the vessel. Each stairway is built of teak wood, with brass fittings, has ample width for a crowd, and altogether has rather an ornamental appearance. The passengers, of course, are landed both from the upper and lower decks at the same time, and are admitted to the boat in the same manner, so that the least possible amount of time is consumed in taking on and discharging the passengers.

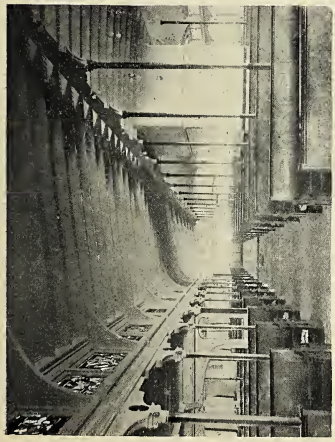

Note
Seats spaced
20 Centers
Length over all 230'0"
Length inside Rubber Posts 200'0"
Beam Moulded 40'0"
Beam to inside Guard Plate 62'0"
Beam over wood Guard 64'0"
Depth Mld at Guard 16'6"
Depth Mld at Sheer Strake (About) 16'10"
Depth Mld at center to top of Crown 17'0"
Depth of Hold 14'10"
Tumble Home 6 in 11 6"
5" Tube
6 Spring in 02 feet
5 x 2½ x 3 x 12 4 lbs
Z Bar
3 Tube
Spaced 6 ft.
midship to ⅜ at Ends
⅜ midship to ⅝ at Ends
⅜ whole length
⅜ Intercostal
Floors 20 x ⅝ ⅜ under E. & B.
Reverse Bars 3 x 2½ x ⅝ for ½ L to ¼ at ends. Double under E. & B.
Alternate Reverse Bars Stop Here
3 x 5 x ⅜ midship to ⅝ at Ends
Frames 3 x 5 x ⅜ for ½ L to ⅝ at ends
3 Tubes midship to (Spaced about 8 feet (See Plan)
3 x 5 x ⅜ midship to ⅝ at ends
⅝ Flange 6 x 13.75 lbs.
¾ Plate
No Sheer on Guard Line

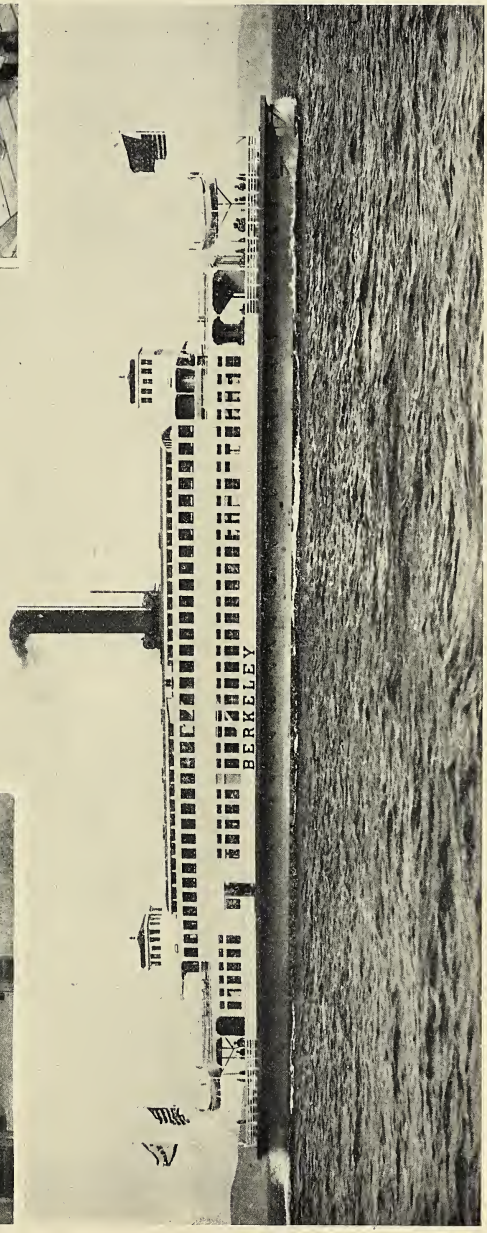
CROSS SECTIONS OF DOUBLE SCREW FERRYBOAT BERKELEY.

The main deck is provided with large seating capacity, and the trunk for the engine and smoke stack occupies the minimum amount of space, because of the cylinders of the engine coming beneath the deck. Under the main deck there have been placed the bar room, toilets and restaurant at one end, and living quarters for the crew at the other end. These arrangements, while they met with a good deal of criticism before the boat was put into service, have since become a favorite arrangement with the traveling public. This is true, however, of all departures along new lines.

The boilers of the *Berkeley* are two in number, 10 ft. 10 in. dia., 19 ft. long, double ended, with two 36 in. corrugated furnaces at each end, carrying a pressure of 165 pounds of steam. There are 304 plain and 136 stay tubes 2 1-2 in. by 7 ft. long. The engine is triple expansion, with cylinders 22 in., 34 in., and 56 in. by 36







VIEW OF FERRYBOAT BERKELEY UNDER STEAM—UPPER DECK ACCOMODATION AND ENGINE.

in. stroke, and at 125 revolutions develops 1,450 indicated horse power. The two propellers are cast solid of bronze, 8 ft. dia. by 14 ft. pitch, with four blades and an expanded area of 30 6-10 sq. ft. The engine, as shown in the photograph, is provided with a steam reversing gear, box guides for the cross heads and a horseshoe thrust-bearing at each end. The condenser is cast in with the back columns; the piston rods are all provided with metallic packing; the air pump is independent of the engine, and the circulating pump is a centrifugal pump.

During the first weeks of her trial, a rather annoying circumstance occurred. At the season of the year when she was put into service, the bay was filled with young spawn. These little fish were so small that they were taken in with the circulating water and almost blocked the ends of the condenser tubes. The trouble was overcome by reducing the size of the holes in the strainer of the suction to the circulating pump.

The boilers are provided with two independent sets of blowers, designed and built by the Union Iron Works, to furnish air to the Howden system of forced draft for the boilers. The double set of blowers have been provided because of the hard service on this route, so that at no time could the boat be crippled for lack of draft.

She is also provided with two independent electric plants; one a compound verticle engine, with cylinders 7 1-2 in. and 13 1-2 in. by 6 in. stroke, and a 400 light 16-candle-power machine. The other is an auxiliary lighting plant of 100 lights, placed for day service, or at any time when only a few lights are required.

The *Berkeley* is provided with four water-tight bulkheads, reaching from her keel to the main deck, without an opening in any one of them. This was done with a view to guaranteeing the safety of the vessel, as supposed water tight doors are almost invariably found open when wanted. There is a complete system for fire, with hose and reels, and life preservers are stored beneath the seats, perfectly accessible to even the smallest child.

The vessel was designed, built and engined by the Union Iron Works, and since she was put into service has given entire satisfaction.

S. Y. Josephine.—The new steam yacht *Josephine*, building at the yard of Neafie & Levy, Philadelphia, Pa., will soon be ready for sea. The dimensions of this vessel are: Length, 216 ft.; beam, 30 ft. 3 in., and depth, 27 ft. She is schooner-rigged, and is fitted with quadruple expansion engines to develop 3,200 I. H. P. Steam is supplied by two Scotch boilers, fitted with Ellis & Eaves draft. P. A. B. Widener, of Philadelphia, is the owner, and he is a member of the New York Yacht Club. The yacht will be very luxuriously fitted and finished, and it is reported will cost, when completed, about $500,000. The former yacht of this name, owned by Mr. Widener, was sold to the Government during the Spanish war period and renamed the *Vixen*.

At the Norfolk Navy Yard the torpedo-boat *Talbot* is being equipped with oil burning apparatus for the purpose of carrying out a series of experiments in the use of fuel oil. The trials will probably be made on Chesapeake Bay.

STEAM PIPES ON VESSELS—MATERIALS USED AND CAUSES OF FAILURES.—II.*

BY J. T. MILTON.

IRON AND STEEL PIPES.

The properties of wrought iron, mild steel and cast iron are too well known to require lengthened description. In making either wrought iron or mild steel welded steam pipes the tubes are made from rolled strips or plates, the edges of which are beveled by machine, and the weld is always lap, not butt. In all but the largest sizes the welding is done in rolls at one heat the whole length, but in the largest sizes of pipes it is done piece by piece, in a similar way to the welding of boiler furnaces. In wrought iron a free welding quality is usually selected in preference to a very strong iron, soundness of weld being considered to be of the first importance. In mild steel the very mildest qualities are selected for the same reason. With either material the requirements of manufacture, except in the cases of the very largest pipes, are such that the thickness is in excess of the requirements of strength for such steam pressures as are now in use, so that when iron or steel pipes are used a very large margin of strength is always provided.

In the case of wrought iron pipes it is usual to trust to the welded joint, but in the case of mild steel, in some cases a riveted butt strap has been fitted, as an extra precaution, over the welded joint. Experience, however, with steel lap-welded boiler and other tubes has shown that, with the mild qualities of material actually used, as reliable welds can be made with steel as with wrought iron. It need hardly be pointed out that butt straps add considerably to the weight and cost, and that every needless rivet hole is a possible source of leakage and trouble, so that if the welds are really efficient, and if they could be tested so as to practically eliminate the probability of defective workmanship, butt straps would soon be dispensed with.

To put such a high hydraulic test upon welded steel as would really stress the material to nearly its elastic strength is impossible, owing to the thickness adopted being much greater than is needed from the requirements of strength alone, and the fact that such pressures would strain the flanges and flange fastenings, but tests of three or four times the working pressure can always be made. It has been suggested by some pipe-makers that, to give confidence in the welds, each steel pipe should be made somewhat longer than is actually required, and that test pieces should be cut off from one or both the ends before flanging and opened out and tested in a testing machine across the weld. In addition, of course, a high hydraulic test would be made after the flanges are fitted.

Flanges for wrought iron or steel pipes may be welded to the pipes, but usually they are screwed on. In some cases they have been riveted to the pipes. Successful plans are shown in Fig. 3, in which the flanges have been forged out of the solid without weld, and screwed on the pipe with a diminishing thread. The thread extends through the whole thickness of flange, but in more recent practice the flange overlaps a part of

*A paper read at the Fourteenth Session of the Institution of Naval Architects, London.

the pipe without thread. In either case the flanges are caulked on both sides to ensure steam tightness.

When wrought iron or steel pipes are used the designs are generally made so that individual pipes are straight, or nearly so. It may be of interest, however, to know that if bent pipes are really required they can be made with a radius of three times the bore for pipes below 6 in. diameter and four times the bore for pipes up to 12 in.

CAST IRON STEAM PIPES.

In the paper of 1895 it was stated that cast iron steam pipes had been used with success for many years, and a list was given of several vessels in which such pipes were fitted, and the periods during which they were in use were also recorded. In most of these vessels the cast iron pipes are still in service. The almost invariable use of cast iron for stop valve chests, etc., shows that as a material it can be relied upon for strength and durability, and the experiences with the vessels referred to show that pipe designs can be made permitting the use of rigid material. When wrought iron or steel pipes have been used for modern vessels

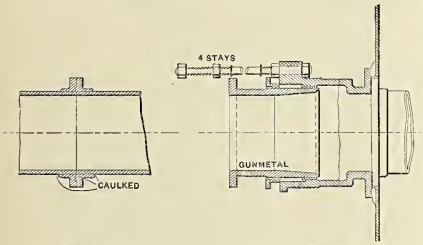


FIG. 3.

FIG. 4.

experience has shown them to be admirably adapted for their purpose, and no trouble whatever has been experienced with regard to their corrosion.

Having now discussed the qualities of the different materials used for steam pipes, it will be well to refer to the conditions which the pipes have to fulfil in actual use.

PIPES UNDER WORKING CONDITIONS.

The first condition to be noticed is that the pipes have to be strong enough to withstand the pressure to which they are to be subjected. In the case of wrought iron or steel, as has already been stated, conditions of manufacture require such a thickness that the strength is more than ample. Copper pipes, however, may easily be made of less strength than sufficient. The usual practice of marine engineers is to take the Board of Trade rule as a minimum. The rule is as follows:

Thickness in inches

$$= \frac{P \times D}{6{,}000} + \frac{1}{16} \text{in.}$$

for brazed pipes, and for seamless pipes not over 8 in. wide,

$$= \frac{P \times D}{6{,}000} + \frac{1}{32} \text{in.}$$

P being the working pressure in lbs. per square inch, and D the inside diameter in inches.

When making copper pipe, either from sheet or from straight lengths of tube, it is usual to make the bends from material one gauge thicker than would be used for straight lengths, and if the bends are very severe, to use two gauges thicker. This is necessary, as the material at the back of the bends is thinned in working. It must not be lost sight of that the extra thickness remains over the greater portion of the pipe, which is, therefore, rendered more rigid than it would be if it were uniformly of the minimum thickness.

Regarding questions of strength only, it is well known that in cylinders subjected to internal pressure the circumferential stress produced in the material is double that in a longitudinal direction. A pipe under hydraulic pressure will, therefore, always yield first by bursting open along the line of least strength, usually the seam. A reference to the failures which have actually occurred in practice, however, as given in the appendix, shows that most of the fractures occur circumferentially at or near the flanges, and are obviously due to longitudinal stresses. The causes of these must, therefore, be looked for from other than internal pressure.

The next condition to be noted is that when in use the pipes will be much hotter than when they are fitted up, or when not in use. The temperature of steam at 200 lbs. pressure—a common pressure now—is 388 deg. F. At 300 lbs., at which some boilers are being worked, the temperature is 422 deg., so that when in use the temperature of the pipes may be from 350 deg. to 390 deg., or even more, in excess of that at which they are fitted up. The co-efficient of expansion of iron or mild steel for a range of 360 deg. is .0024, and that of copper is .0037. Pipes, therefore, of these materials will tend to become longer when in use by these amounts. In addition to this the boiler itself, to which one end of the length of pipe is attached, also expands, and thus raises one end of the pipe from 3-8 in. to 1-2 in., according to the size of the boiler, while the end attached to the engine remains stationary. The necessary alteration of form of the pipes to allow for these expansions must be provided for in the design of the steam pipes, either by providing properly constructed expansion joints, which will allow the requisite freedom of motion, or by making the pipes of such form that the movements can take place, owing to the ductility of the material, without producing undue stresses on the pipes themselves, or in their connections to the stop valves and engines.

When cast iron or wrought iron pipes are employed it is usual to consider that their rigidity is too great to allow of the expansion to be accommodated by the flexibility of the pipes themselves, and generally, therefore, expansion joints are fitted to them. An example of such a joint is shown in detail in Fig. 4.

With copper pipes, however, it is more often considered that the pipes will be sufficiently flexible, and the material sufficiently ductile to permit of their repeated contraction and expansion without the need of stuffing-box expansion joints, and consequently these are rarely fitted. Undoubtedly pipes can be made sufficiently flexible to meet all practical requirements; but,

unfortunately, many of the designs in general use, sometimes combined with the faulty workmanship of not properly annealing the pipes, are such as to give continued trouble in keeping the flange joints tight, and in some instances also in producing rupture of the pipes at or near the flanges. Some of these designs will be presently referred to.

It must be borne in mind that the hollow cylindrical form is one naturally possessing great strength and rigidity in proportion to its weight, and hence its general use for columns, etc., where stiffness is required. This property is often forgotten when dealing with pipes, and they are often credited with far more flexibility than they possess. In questions dealing with the rigidity or flexibility of pipes it is well to remember that if a solid bar and a hollow tube of the same material, and the same length and shape, are subjected to the same loading, producing either traverse bending or torsion, or the two combined, the deflections will be identical if the diameter of the solid bar be equal to

$$\sqrt[4]{D^4 - d^4},$$

where D and d are the outside and inside diameter of the pipe. A bar of this diameter may, therefore, be looked upon as the equivalent of the tube when considering its flexibility, and if such a bar be flanged at the ends like the pipe, and attached to the stop valves, etc., by the flanges, the strains which the expansion, etc., will put upon the flanges of the stop valves will be the same by the bar or by the tube.

Let us now consider a pipe such as is commonly employed, say such as fitted in one of the cases referred to in the appendix. This pipe forms a right-angled bend, the two arms being 2 ft. and 6 ft. long, respectively; the inside diameter of the pipe is 6 in., and its thickness is .212, so that its stiffness or rigidity is equal to that of a solid bar of copper 4 1-8 in. diameter. The expansion due to its temperature would, if not resisted, increase the lengths of the two arms by over 1-12 in. and 1-4 in. respectively, and in addition one end is raised up by the expansion of the boiler about 1-2 in. The pipe, therefore, has to have such force applied to the flanges at the two ends as would bend a solid bar 4 1-8 in. diameter till the arms were shortened by the amounts mentioned, as well as place one end 1-2 in. vertically, and at the same time there must be such bending moments applied to the ends as will keep the flanges in the same plane. These forces have to be borne by the thin metal of the copper pipe at the parts where it is brazed to the flanges. If a larger pipe were considered the forces involved would be even greater in proportion. If the copper is at first well annealed these forces, being more than sufficient to produce stresses beyond the limits of elasticity, will doubtless permanently alter the shape of the pipe. At the parts where deformation takes place the copper will be somewhat hardened. When the pipe is cooled down it will tend to regain its original shape and length, and strains will be set up in it of opposite character to those caused by heating it. Each raising and lowering of steam will, therefore, bring alternating stresses on the pipe, each time tending to harden the material and decrease its ductility at those parts where most deformation takes place. There is no wonder, therefore, that in time the whole of the ductility is destroyed, and the pipe cracks round near one or both flanges.

From the diagrams shown in Figs. 1 and 2 it will be evident that, while on the one hand the more thoroughly annealed the material of the pipe is the more easily it will be deformed, yet, on the other hand, when well annealed the yielding power or ductility of the copper is such that very considerable deformation can take place without danger. Fig. 2, however, shows that with hard copper very much less yield can take place without the production of great strains, and consequently of great risk.

It may be well to point out that the expansion of iron is only about two-thirds of that of copper, so that the deformation in an iron pipe would be only two-thirds of that of a copper pipe; but, on the other hand, it is a stronger material, and in general, iron pipes would be thicker than those of copper, so that with iron there is considerably less flexibility than with copper.

When copper pipes have to take up the expansion and contraction by their alteration of form it cannot be too strongly urged that they should be anealed uniformly throughout their whole length. Unfortunately, the practice on this point is not well established. Some coppersmiths are particular in seeing that this is done; generally, however, only the bends, that is, the parts where the pipes have been bent and therefore extra hardened, are annealed, the straight portions being left unannealed, whilst other coppersmiths leave even the bends unannealed. The portions near the flanges always become annealed when the flanges are brazed on, and unless the pipes are afterwards annealed their whole length it happens that the whole of the deformation strains become concentrated upon the soft part at the flanges where there is the greatest tendency for rupture to be produced.

ANNEALING BENT PIPES.

From what has been stated it would appear to be desirable that copper pipes which have to take up expansion deformations should be periodically annealed. This, however, brings up the question as to how the annealing of a bent pipe can be effected. The workshop practice is at best a makeshift one, the usual and practically the only plan being to heat successive portions of the pipe over an open coke fire, the workman turning it round and shifting it about over the fire until each part in turn is thought to have been raised to a red heat. Irrespective of the difficulty of getting the inside of a large bend near the coke fire, this method leaves much to be desired, and involves a great risk of some parts being left hard, while the remainder is annealed. An unhomogeneous pipe may be in a worse condition than one wholly unannealed, and hence the reluctance of marine engineers generally to have pipes which have been satisfactorily at work for some time taken down and possibly injured in the attempt to anneal them. It is not too much to ask that our engineers should, if they will continue to use large and thick copper pipes, provide proper furnaces where the pipes may be uniformly heated throughout their whole length at one operation.

USES OF EXPANSION JOINTS.

There is, however, no absolute necessity in most

cases for using bent pipes. Straight pipes can nearly always be designed to meet all requirements, and the expansion of these can be provided for by expansion joints of the form shown in Fig. 4. These joints are, it is true, objected to by some engineers as being likely

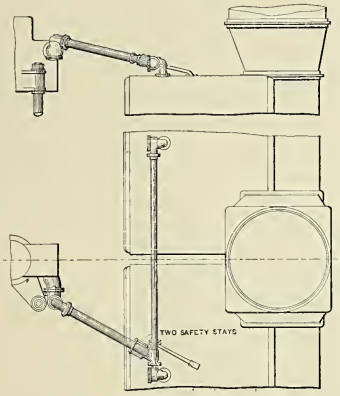


FIG. 5.

to be a continual source of trouble, but that this is not a correct view is shown by the fact that in our very largest mail boats they have been fitted and found to present no great difficulty in keeping them in order, while one of the largest engineering concerns on the East Coast practically used no other design for very many years for their main steam pipes, and their engines and arrangements are at least as popular as those of any of their competitors. Further, it must be remembered that, even if some trouble is experienced in keeping stuffing-boxes in order, serious troubles with leaky joints are by no means unknown, where the expansion has to be met by straining the pipes themselves. Figs. 5, 6 and 7 represent plans which have been successfully adopted for steam pipes in which all the pipes are practically straight and the expansion provided for by expansion joints.

In providing for the expansion to be taken up by ex-

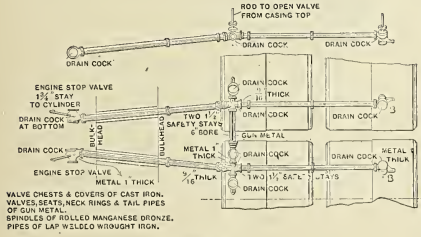


FIG. 6.

pansion joints it is necessary to insure that the lengthening of the pipe shall really take place by pushing into the joint meant to receive it, and that, on the contrary, the end of the pipe shall neither be stationary in the joint nor drawn out of it. This can only be insured by making arrangements for fixing the expansion joint in position, and also securing the other end of the pipe to a fixed position, either by means of long stays attached to the expansion joint itself, or by some other means.

The blowing out of the pipe by the steam pressure may possibly take place if there is a large bend in the pipe, as is seen in some designs. In such cases the preventive fastening should be secured to the bend, not to the pipe near its free end. Expansion joints are often fitted with what are called safety stays to prevent the pipe being blown out. When these are short and fitted too near the free end of the pipe they are either useless or the expansion joint itself is useless, as they cannot come into service if the pipe expands into the joint, as it is intended to do. They may, moreover, be an absolute source of danger, and at least one of the failures of steam pipes recorded was due to their being fitted. When steam is up and the pipe expanded the safety flange should be some distance off the nuts of the stays. If in this condition the nuts are thoughtlessly or ignorantly screwed up to the flange, on the pipes cooling down and contracting they will be subjected to great strains and something must fracture to relieve them. If such stays are fitted, therefore, the nuts on them should be carefully adjusted when cold and be fixed in place, either

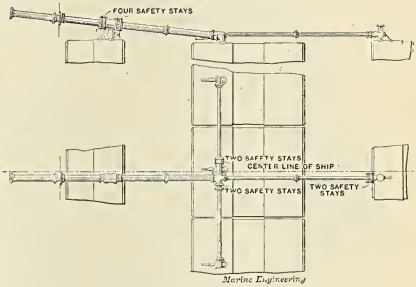


FIG. 7.

by pins through them or by ferrules placed over the stays of such a length that the nuts cannot be screwed down too far. Properly designed pipes, however, will not need these stays at all. In none of the plans shown in Figs. 5, 6 or 7 are these stays really required, although they have been fitted.

SUPPORTING STEAM MAINS.

Whilst referring to the expansion of pipes it will be well to call attention to the methods of supporting long lengths of pipe. These should be so arranged that, while giving the necessary support and preventing vibration, they will not of themselves prevent the movement of the pipes due to their expansion and that of the boilers. If this is not provided for the supports may possibly put much greater stresses on the pipes than would result from their being left altogether unsupported. Unfortunately, this point is often neglected by the designer, the hangers being arranged on the vessel by the mechanics who fit them in place, who may not fully appreciate all their requirements.

EXPERIMENTAL MODEL BASIN AT WASHINGTON, D. C., FOR THE U. S. NAVY.

In our issue of March, 1898, we published a brief description of the model experimental tank at Washington, then under construction for the Navy Department, together with photographs showing the progress of the work. Now, through the courtesy of Rear-Admiral Philip Hichborn, Chief Constructor of the Navy, we are enabled to publish a description of the completed station with illustrations of the principal apparatus employed.

The value of towing experiments upon small scale models of ships for the purpose of deducing the resistance of a full sized ship from that of the small model was demonstrated by the late William Froude, who, at his own expense, started a small tank for such experimental work at Torquay, England, about 1870. The English Admiralty subsequently recognized the value of his work and assisted him in it, later building a larger basin at Haslar, near Portsmouth, which is now in charge of R. E. Froude, son of William Froude. Other governments, notably Italy and Russia, were induced to establish model basins, which were largely copies of Froude's basins; and one firm of private builders, Denny Brothers, of Dumbarton on the Clyde, Scotland, was sufficiently enterprising to build a basin for their own use.

The Construction Bureau of our Navy Department has appreciated for many years the value of an experimental basin, but it was for a long time unable to secure an appropriation for the purpose. Congress finally, about two years ago, granted $100,000 for this work, the grant being largely due to the efforts of the late Congressman Hilborn. The basin proper was completed the latter part of last year, and the special machinery and apparatus have now just been completed and installed, after a good deal of delay due indirectly to the war with Spain.

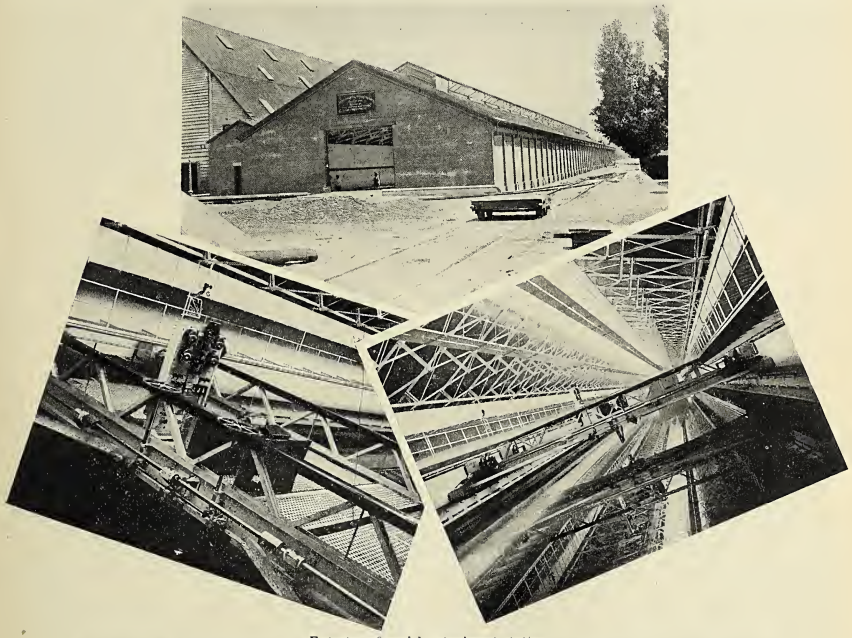
The basin is located in the southeast corner of the Washington Navy Yard. The building is 500 ft. long and about 50 ft. wide inside. The water surface of the basin is slightly shorter than the building, being about 470 ft. long. The deep portion is about 370 ft. long, the south end, from which runs begin, being shallow. The water surface is 43 ft. wide, and the depth from top of coping to the bottom of the basin is 14 ft. 8 in. The basin is considerably larger than any other in existence. The nature of the ground was such as to render the construction of a thoroughly tight and stable basin somewhat difficult, but owing to the small space available at the Washington Yard, it was necessary to locate it upon its present site. The bottom of the basin proper is made up of a layer of broken stone upon which is a thin layer of concrete, then 1-2 in. Neuchatel asphalt, then about 9 in. of concrete in 16 ft. lengths, the keys between the various lengths being filled with Bermudez asphalt, and the whole inside surface covered with the asphalt. The heavy side walls are 6 ft. thick at the bottom, 6 ft. deep, and about 4 ft. 6 in. thick on the top, not counting the moulded stone coping. They are in 40 ft. lengths with a square key between adjacent lengths filled with Bermudez asphalt. The side walls rest upon a double row of piles, and in addition there is sheet piling completely around the deep part of the tank. The shallow part of the tank at the southern extension is also carried on piling, as it actually overhangs the water.

The law authorizing the construction of the model basin also authorized experiments to be made for private shipbuilders, provided they defrayed the actual cost of the same, it being understood, of course, that such experiments should not interfere with naval work. This being the case, it was necessary to lay out the plant with a view to the rapid and economical turning out of routine experiments, and to this end the endeavor has been throughout to use machinery for as many of the operations as possible. The foreign tanks invariably used paraffine for the construction of models, and generally make them from 10 to 14 ft. long. The climate of Washington is so warm in the summer that it was found impossible to obtain paraffine which would retain its rigidity satisfactorily, and, moreover, it was the desire of the Bureau of Construction and Repair to make the models as large as possible, thus eliminating one source of inaccuracy in applying the model experiments to full-sized ships. For these reasons wood was adopted as the material for the models, and after some difficulty a satisfactory varnish was found which rendered the surface of the wood to all intents and purposes absolutely water tight. The standard length of model used is 20 ft. A model 20 ft. long may not seem much larger than one 12 ft. long, but when it is remembered that the displacements of these two are respectively as 8,000 and 1,728, it will be seen that the 20 ft. model is nearly five times the size of the 12 ft. model.

The method of building the models is as follows: The "lines" of the ship invariably include a body plan giving sections at moderately close intervals. From this body plan new sections are drawn to the proper size for a 20 ft. model by means of the eidograph or large pantograph. These sections are cut out of paper, then transferred to wooden boards, which are sawed to shape. These boards are then erected in their proper relative position upon the erecting table, each board section being clamped in a vertical plane. They are then covered with battens about 1-2 in. thick and tapering from amidships towards the end, making a "former" model, the surface of which is planed smooth. In cutting out the sections allowance is made for the thickness of the battens, which have to be nailed upon them. Meanwhile a rough block of shapes and dimensions to enable the finished model to be cut from it has been prepared and glued together under pressure in a large hydraulic press. This block is placed upon the upper table of the model cutting machine, the "former" model being placed upon the lower table. The model cutting machine works upon the principle of the Blanchard lathe, a roller traversing the surface of the "former" model, and saws, or cutters, working upon the surface of the model proper. The bulk of the material is removed from the block by means of the saws, which are shifted along a short distance at a time. Rotary cutters are then applied which finish the surface of the model very close to the desired shape. The model is then removed from the cutting machine and finished by hand; a very small amount of hand work,

however, being found necessary. It is then ready for varnishing and the attachment of any appendages, such as bilge keels, struts, etc. It is finally taken to the measuring machine and careful measurements made of its exact form and shape, which not only enable the staff to determine whether the model represents the lines desired, but give an exact record of the actual shape.

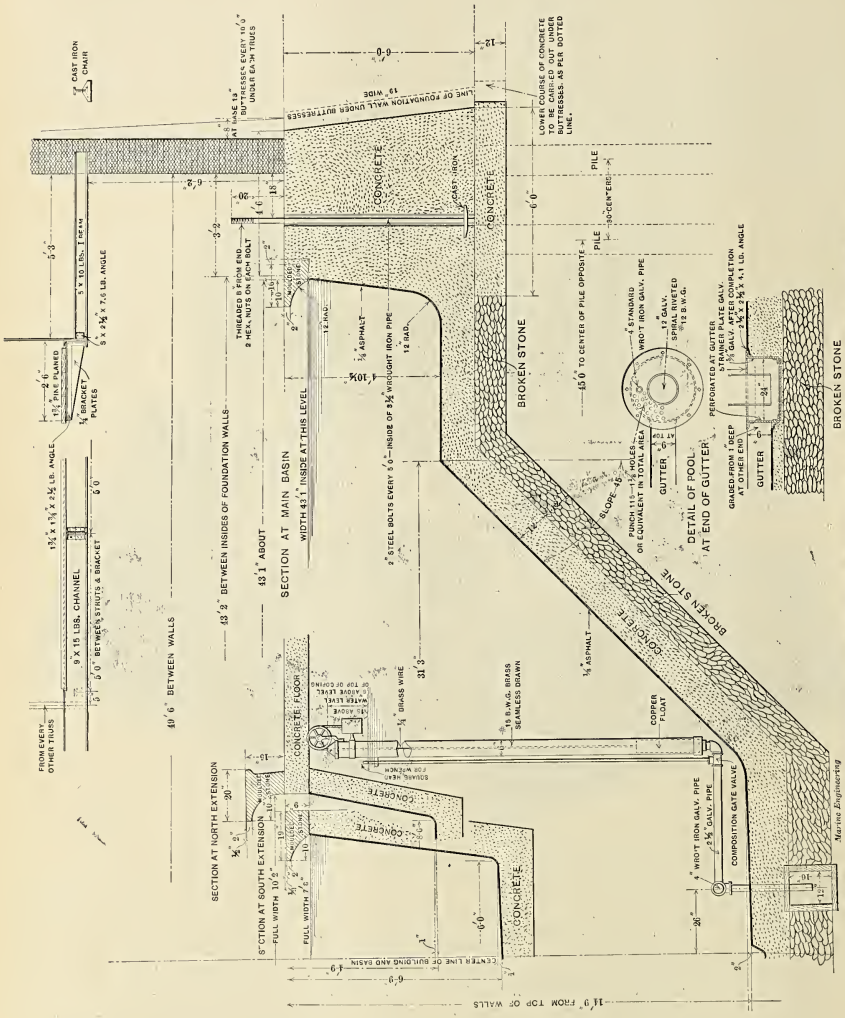
The model is now ready for the towing experiments. In the accompanying engravings the carriage used for this purpose is shown. It runs upon eight wheels and spans the full width of the basin, as shown. The platform in the center carrying the recording apparatus can be raised or lowered at will. Electricity is used to drive the carriage, and it may be mentioned, incidentally, that it is used for all mechanical work in connection with the model tank. The speed of the carriage is varied not only by making various combinations of the four motors—one to each pair of driving wheels—but by controlling the output of the generator in the power station, which is perhaps 100 yards from the tank. This control is on the Ward-Leonard system, and is very similar to that used to control the motion of heavy turrets on board ship. By means of a resistance box on the carriage the current through the field coil windings of the generator is increased or decreased at will. The revolutions of the generator being kept constant by a delicate governor the amount of current generated varies with the amount of current through the field coils of the magnet. The whole of the current generated is passed through the motors, and in practice it is found that a very exact regulation of speed is obtained by this combination. The carriage itself, with its fittings, weighs in the neighborhood of 25 tons, so that it alone forms a kind of fly-wheel and is not subject to sudden variations of speed. The speed of the carriage can be varied from 1-10 knot an hour, or 10 ft. per minute, to 20 knots an hour, or 2,000 ft. per minute. The principal difficulty in connection with the use of high speeds, which, while not necessary for the bulk of the experiments, will be of great value in certain special experiments, is to stop the carriage when it is once under way. The electrical control acts as a brake, because when the current is shut off the motors become generators, but this could not be relied upon for high speeds, since the sudden rush of current due to possible unskillful manipulation would throw the circuit breakers, thus opening the circuit and cutting off the current entirely. For these reasons there is at the north or terminal end of the basin a double system of brakes to take hold of the carriage. The first is a friction brake consisting of two strips of iron on either side, pressed together by hydraulic cylinders. These are forced apart by a slipper on the carriage about 10 ft. long, which, as well as the brake strips, is kept thoroughly oiled, so that the coefficient of friction for stop-

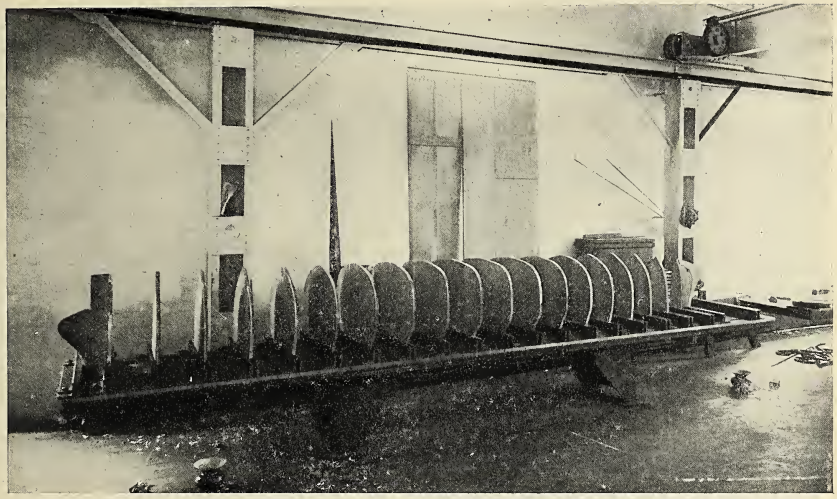


Exterior of model experiment station.

Recording table and instruments on carriage. *General view of interior, showing carriage across tank.*

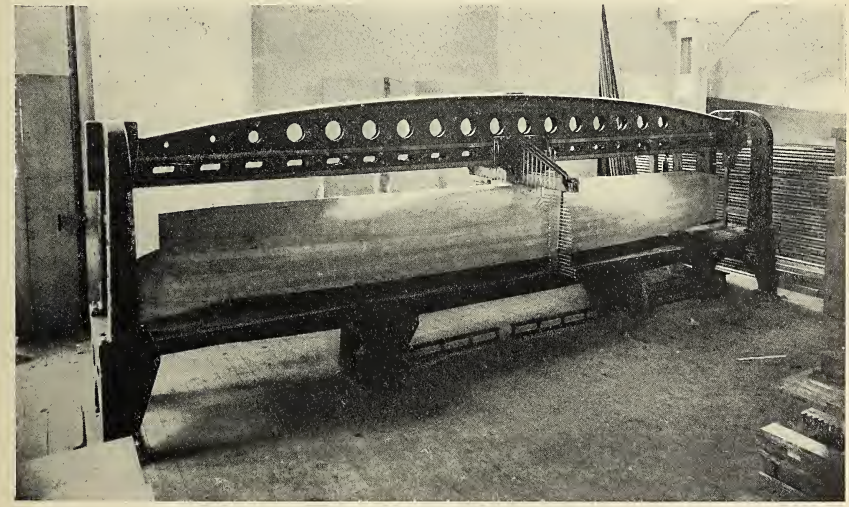
ping, though low, is fairly definite, and sudden jerks are avoided. The pressure in the hydraulic cylinders is controlled by an accumulator and a pump driven by electricity. Great care has been taken in connection with this part of the installation that it may be always in working order, and any trouble or breakdown, except that of the pump itself, which runs all the time, will simply result in setting the pressure at a maximum. This maximum is 600 lbs., but it has been found by actual experiment that with 500 lbs. pressure the carriage is brought safely to rest when it enters the brakes at a speed of 20 knots. It is not expected in practice to repeat this often, since even for the high speed runs the electrical brake will be used to reduce the speed of the carriage before the friction brake is used. In addition to the friction brake there is what is called


SECTION AT MAIN BASIN
SECTION AT NORTH EXTENSION
SECTION AT SOUTH EXTENSION
DETAIL OF POOL AT END OF GUTTER
BROKEN STONE
CONCRETE
PILE
CAST IRON CHAIR
43' 2" BETWEEN INSIDES OF FOUNDATION WALLS
43' 1" ABOUT
40' 6" BETWEEN WALLS
CENTER LINE OF BUILDING AND BASIN
11' 9" FROM TOP OF WALLS
U. S. EXPERIMENTAL MODEL BASIN IN WASHINGTON, D. C.—DETAIL OF BASIN AND COPING.
Marine Engineering



ERECTING TABLE WITH CROSS SECTIONS OF "FORMER" MODEL IN POSITION.

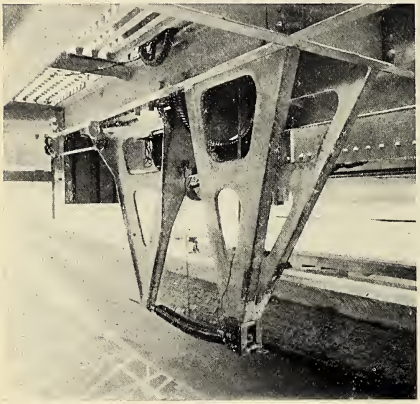
the emergency brake, so that in case the friction brake fails for any reason, the carriage would still be caught. This brake consists simply of a piston about 16 in. dia., working in a cylinder which is submerged in the water of the tank and connected by wire cables to a hook which takes hold of the carriage. The head of the cylinder has a round hole and the piston rod is tapered so that as the rod is drawn out by the motion of the carriage the hole is gradually closed, the whole being almost exactly upon the principle of the hydraulic gun



APPARATUS FOR MEASURING THE EXACT FORM OF THE FINISHED EXPERIMENTAL MODEL.

recoil brake. An escape is provided for the water around the piston when it starts from rest, to avoid sudden accelerations from the whole mass of water in the cylinder.

The dynamometric apparatus is designed to avoid entirely the use of multiplying levers or other devices involving the possibility of friction, and here again elec-

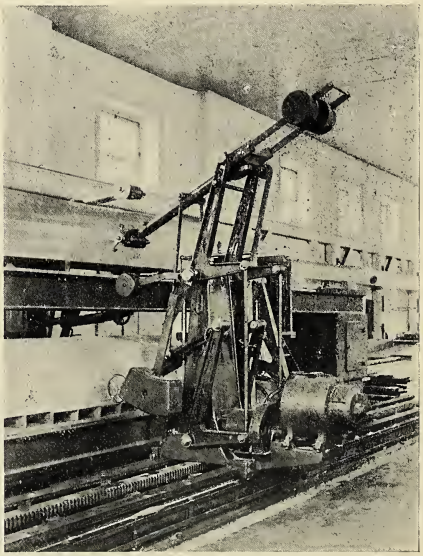


TOWING BRACKET UNDERNEATH CARRIAGE.

tricity is enlisted. The recording drum is fitted with apparatus for recording the time and distance, as usual. The resistance is measured directly by a spring which is in view underneath the carriage. The forward end of the spring is attached to a bracket which is screwed forward or back by an electric motor, and a rigid arm runs up from the bracket, with a pencil recording its position on the drum. The record then is of the position of the forward bracket. The after end of the spring takes hold of a small cross-head to the other end of which again is attached a towing rod which takes hold of the model. This cross-head has a very slight play between stops in the after fixed bracket, and when it touches either stop closes an electrical contact, which again throws an electric clutch, by means of which the motor, running all the time, screws forward or back the forward bracket, thus increasing or decreasing the tension of the spring until the contact is opened again.

There are many refinements which cannot be indicated in this brief description; for instance, the operator can throw either clutch at will or set them to work automatically. In practice, when about to make a run, the operator works the bracket forward to the immediate vicinity of the position which he knows it will assume during the run, the approximate speed of which he knows. The carriage is then started, and after a uniform speed has been obtained, which, for speeds up to 12 knots, is done within 50 ft., he throws in by a single motion of one handle the automatic appliances which start the drum and record time, distance and resistance. In this way the resistance pen has to move but a small distance to reach the position of equilibrium and almost immediately becomes steady. It will be seen that with this device friction is eliminated. The accuracy obtainable depends upon the closeness with which the automatic stops at the after end of the spring can be set. In practice it is found that these can be set to give a play of about the fiftieth of an inch, and as the springs will extend 10 in. the results obtained are practically exact as indicating the pull of the spring.

It now remains to describe the method by which the amount of this pull can be determined in any instance. There is fitted at the starting end of the basin a kind of weighing machine with one vertical and one horizontal arm. This is delicately balanced, and when the model has been connected up and is ready for towing, a certain spring being in use, the vertical arm, or rather a knife edge which bears upon the vertical arm, is connected to the model. A known weight is then put into the scale pan attached to the horizontal arm. The automatic attachment in connection with the dynamometer spring is thrown into gear, and the weighing machine is screwed forward or backward until it is in perfect balance and the record pen recording the position of the spring is at rest. It is evident then that the pull of the spring is exactly equal to the weight in the scale pan. There are a number of pens which can be shifted parallel to the recording pen and set in a definite position to record upon the drum. One of these pens is set to correspond to the position of the



MODEL CUTTING MACHINE.—"EXPERIMENTAL MODEL" ABOVE, "FORMER MODEL" BELOW.

resistance pen, then another weight is put into the scale pan, a second pen set to record the resistance, and so on. It is evident then that when the run is made these fixed pens mark off upon the paper a scale

for resistance, avoiding all complications of corrections for temperature of spring or anything else. A complete double outfit of springs is already provided for measuring resistance from 1 lb. up to 500 lbs., and for special work additional special springs will be obtained.

In connection with the question of temperature, it is impossible to avoid a certain variation of the temperature of the water, but as ample heating facilities are provided, it is not expected that the variation of temperature during the year will be sufficient to necessitate correction in the results of experiments on this account. The basin is filled from the water system of Washington and will hold one million gallons. Two electrical centrifugal pumps are provided, the larger of which will empty the tank in about four hours. The smaller pump is a 4 in. pump used for draining the last water from the basin and also for pumping the water from outside the basin to avoid the possibility of undue pressure upon it in case it is left empty for some time. This is necessary, since the basin is but a short distance from the Potomac river and extends 8 or 9 ft. below mean tide level. A gauge indicates the level of the outside water, which is found to be, as a rule, about 6 ft. below the water in the basin.

The leakage from the basin, which is very slight, and the evaporation, are made up with filtered water, an animal bone filter being installed with a capacity of from 50 to 100 gallons per minute, depending upon the turbidity of the water. In practice a small stream of fresh filtered water is kept running into the basin all the time, and the level maintained wherever desired by an adjustable overflow.

The building and tank or basin proper were designed by the Bureau of Construction and Repair, as well as the machinery for making the models. The electrical installation was fitted by the General Electric Company, many of the electrical details of design being also due to them. The carriage proper was built by the William Sellers Co., the dynamometer apparatus partly by the Sellers Co. and partly by Saegmuller, of Washington, who also built the large eidograph. All of these are upon the designs of the Bureau of Construction and Repair. The model cutting machinery was built by Detrick & Harvey, of Baltimore, Md., to the designs of the Bureau of Construction and Repair.

The model basin staff is now at work upon experiments to determine frictional coefficients of varnished surfaces and other constants needed in its use. Experiments are being made as opportunity serves upon models of the naval vessels already built and tried for the purpose of accumulating data which will be constantly needed during the life of the tank. As soon as preliminary lines of the new third-class cruisers authorized at the last session of Congress are completed, experiments will be made with them in the tank with a view to introducing any refinements or improvements found desirable.

According to *The Steamship*, "a Belgian engineer has invented a hydraulic propeller for ships which, it is claimed, attains a speed of 40 knots per hour without increasing the consumption of fuel. It is intended to fit the invention to a large steamer, and a run to America and back is to be made, with the object of demonstrating its superiority over the ordinary screw propeller."

AMERICAN SCHOOLS OF MARINE ENGINEERING.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS AT SCRANTON, PA.

Courses of Instruction for the Benefit of Operative Marine Engineers and not Designers —Tuition by Mail Exclusively.

The International Correspondence Schools of Scranton, Pa., hold a unique place among educational institutions. Their courses of instruction in the engineering trades and professions are developed exclusively through the mails; their students are in every part of the world and engaged in regular business pursuits; and most of them have passed the age at which the educational period is generally considered to have terminated. The plan has, however, passed far beyond the region of experiment, and a growth of from one student to 90,000 in less than eight years is sufficiently indicative of its popularity and of the confidence which it has inspired.

The method of correspondence instruction, upon which the schools have been established, was originated in 1891 by Thomas J. Foster, manager of The Colliery Engineer Company. Its origin and location of the schools at Scranton are due to the demand on the part of the miners, in that section, for educational assistance to enable them to pass the mine-law examinations. From a single course in mining and a series of papers prepared by a single instructor, the system has been expanded to cover almost the entire range of technical knowledge with fifty-seven distinct courses of study, and a corps of 120 engineering experts, instructors and assistants, who write and edit the texts used in teaching, and examine and correct the work of students. These are in addition to the subordinate assistance required to carry out the purposes of the system, the business management and its assistance, and the working force of the home office and elsewhere, which bring the entire staff and line of the schools up to about 1,000 persons.

The Marine Engineering Course of the International Correspondence Schools is intended primarily to supply such knowledge to men in the engineers' department of steam vessels as will assist them in becoming engineers or obtaining a higher grade of license. No attempt whatsoever is made to instruct students in the use of tools, instruction being limited to those branches of science a knowledge of which, for obvious reasons, can not be obtained by actual work in the engineers' department. For instance, students are not taught how to file up a cut crank pin. They are, however, taught the use of the indicator, how to read cards, the elements of propulsion, the chemistry of combustion, the principles of steam generation, the use of the salinometer, the theory of compounding engines, the use of condensers and many other similar matters, which in former days had to be learned by self-study or not at all. Owing to the fact that instruction is given entirely by mail, the method of teaching differs entirely from that employed at technical schools. The requirements for entrance are simply the ability to read and write the English language.

THE COURSE OF INSTRUCTION.

Upon enrollment a student is started in the preparatory division, it being assumed that he knows nothing whatever beyond reading and writing. For obvious reasons, it is essential that a student must be well grounded in the fundamental principles before their application can be taught to him. Numerous examples of a practical nature, distributed all through the text-books which the schools furnish free of charge to students, serve to make him familiar with each and every principle and its application. The greatest divergence of the method employed in correspondence instruction from that in vogue in colleges lies in the fact that there is no set time for study, or that any division must be completed within a prescribed time. Each and every student is a class by himself, and studies independently from others. When any part of any division has been completed by a student, he is required to pass a rigid examination, at which he must have an average of 90 per cent to pass. This examination naturally is a written one, and consists of from fifty to one hundred questions covering all parts of any branch of any division, and so worded as to bring out fully a student's knowledge of the principles he has been taught. In examining the answers to these questions the greatest of care is exercised; not only is the final answer checked, but the reasoning and the methods employed by the student in order to arrive at the solution are investigated thoroughly. This can readily be done, as students are absolutely required to work out every example or question in full.

Naturally some students enrolling either for the Marine Engineering or any other course object to starting in at the beginning, claiming that inasmuch as they have been taught the rudiments of mathematics at public schools years ago, they should not be required to go over the same ground again. In such a case the schools give the student the option of taking an examination; if he passes it successfully (90 per cent. being required) he may take up the next division. However, most students find it to be greatly to their own interests to review the rudimentary knowledge contained in the preparatory and intermediate division before taking up the advanced division. But it is an inviolable rule that a student must, by passing a rigid examination, prove that he thoroughly understands one division before he can enter upon the study of the next one. In the advanced division of the Marine Engineering course students are taught as much of the science of Mechanics as required. Upon completion of the advanced division, the study of Geometrical, and practice of Mechanical Drawing is entered upon. Here the student is taught the Use and Care of Instruments, Geometrical Constructions, Representation of Objects, Orthographic Projection, the Conic Sections, Intersections and Developments, etc. When finished, the practice of Mechanical Drawing is taken up. Here special attention is paid to making the student familiar with the production of working drawings, one of the last drawing plates of the course being a complete component of the machinery equipment of a vessel drawn to correct scale. For example, a student is required to prepare a complete working drawing of a double-ended marine boiler; the plate sent to the student being reduced enough to break the scale, and the student being required to make his drawings to the scale marked. Copying is impossible. Furthermore, in drawing these plates the student finds it necessary to do quite a little projecting from one view to another in order to obtain the correct position of lines and points in the various views—the dimensioning of the parts shows him, and makes him familiar with the dimensioning of working drawings.

It has been found advisable to make it optional with the student whether to take Geometrical and Mechanical Drawing before or after the advanced division, but in all cases the drawing division must be completed before entering upon the technical division.

Upon entering the technical division the students commence with Thermodynamics, then taking up the Properties and Generation of Steam. Next, the types of Marine Boilers are studied; then Boiler Construction and Design, Fittings of Marine Boilers, the Feed Apparatus, Feed Pumps, Feed Water Filters, Strainers, Grease Extractors, Heaters, Evaporators, the Salinometer, Combusion and Fuels, Circulation of Water and Forced Circulation Apparatus, Natural and Forced Draft, Rates of Combustion and Management, Care and Repairs of Boilers; also Boiler Explosions and Boiler Tests.

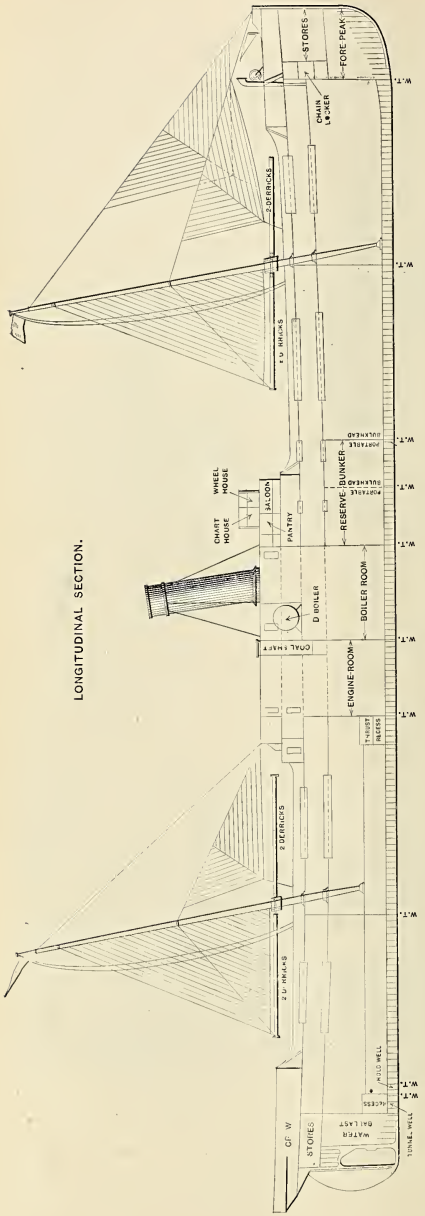
The student now enters upon the study of the use of Steam, commencing with Work and Expansion of Steam. Then the Steam Engine is taken up, and Steam Distribution, Valves, Valve Gears and Valve Setting are followed by the Elements of Propulsion. Upon completion of this part the Indicator, Steam Consumption, Efficiency of Steam Engines, Condensers, Air Pumps, Compounding of Engines, the Beam Engine, the Engine Room Fittings, etc., followed by Management, Care and Repair of Engines are taken up fully. This branch of study is followed again by instruction in Electricity, commencing with the fundamental principles.

Upon completion of the studies the student is then required to pass a rigid general examination covering all branches studied; if passing the same with an average of 90 per cent. a diploma is issued, showing that the student has completed the prescribed studies. This diploma does not carry a degree with it. No attempt is made in the Marine Engineering course to fit men for designers of marine machinery or to make naval architects of them, instruction being rather of such a nature as will make men better qualified in all respects to intelligently care for marine machinery and run the same economically. The principal of the school of marine engineering is John A. Grening, who commenced life as coal passer on the S. S. *Tijuca*, of the Hamburg-South American S. S. Co., and rose step by step to his present position.

The New Pacific Liners.

The Hawaiian Steam Navigation Co. has recently contracted for a fleet of large, modern steel cargo steamers with John Roach & Sons, Chester, Pa., and the Union Iron Works, of San Francisco. Each yard will build two vessels, and these steamers, being of a very successful money-earning class and size, much interest is centered in them. The design and specifications for these vessels were prepared by Flannery &

MAIN BUILDING OF THE INTERNATIONAL CORRESPONDENCE SCHOOLS, SCRANTON, PENNSYLVANIA.



INBOARD PROFILE AND DECK PLANS OF NEW STEEL STEAMSHIPS FOR HAWAIIAN STEAM NAVIGATION CO.

Tritton, naval architects, Water street, Liverpool, Eng. They are each of the following dimensions:

Length over all	430 ft.
Length L. W. L.	415 ft.
Beam	50 ft.
Depth, side	33 ft. 6 in.
Depth, center	34 ft. 6 in.
Load draft	26 ft.

The scantlings of the vessels will be in accordance with Lloyds' three-deck rules, and they will receive the highest rating in this classification society. Each vessel will be fitted with two pole masts, with four large derricks on each mast. Vent derricks will also be fitted. There are four large cargo hatches, and one smaller one. The forward hatch, No. 1, is 21 ft. long and 12 ft. wide. No. 2 hatch is the largest in the ship, being 30 ft. by 16 ft. A small hatch—No. 3—12 ft. by 10 ft., leads to the reserve bunkers. Abaft the bridge house is No. 4 hatch, 25 ft. long by 12 ft. wide, and the after hatch, No. 5, is 21 ft. long by 12 ft. Seven double

U. S. TORPEDO BOAT ROWAN, WITH SPEED RECORD OF 27-2 KNOTS.

drum steam winches will be fitted, and all the appliances for the rapid handling of cargo will be modern and most complete.

The designs call for seven complete steel water tight bulkheads and one partial bulkhead. A double bottom extends from the collision to the aft peak bulkhead, the tanks in this water bottom having a capacity of 1,250 tons of water.

The vessels are of the three decked type, and two of the decks are plated with steel throughout. They have a forecastle, midship house, bridge house and full poop. The forecastle is open at the aft end, but in the inclosure are located the carpenter's shop, paint shop, boatswain's stores, lamp room, etc. The steam windlass is located on the forecastle deck in the open. The chain lockers and forward storeroom are located over the forward trimming tank. The forward part of the midship house will be used for the stowage of cargo. Large coal trunks lead from the main deck to the bunkers below. In the aft of the midship house, alongside the engine casing, are fresh water tanks, ice rooms, storerooms, steam steering gear, galley, oilers' room, water tenders' room, etc. Above the midship house is the bridge house. Around the engine hatch in the bridge house are six officers' staterooms, a mess room, pantry, bath and w. c. Forward of the boiler hatch are the staterooms for the captain, first officer and steward, also three passengers' staterooms, toilet rooms, pantry and large saloon. Situated above the forward part of the bridge house is the chart and wheel house and navigating bridge. The crew are berthed in the poop aft. Twenty sailors have roomy quarters on the starboard side, and twenty firemen and coal passers a similar room on the port side. Convenient wash rooms and w. c. are also located here.

The propelling machinery of each vessel will consist of a vertical triple expansion engine with cylinders 27 in., 45 1-2 in. and 76 in. by 48 in. stroke, designed to indicate 2,500 I.H.P. at sea. Steam will be supplied by four large steel Scotch boilers, each 14 ft. 9 in. dia. and 10 ft. 6 in. long, working with natural draft, with a common stack 80 ft. high above the grate. A large donkey boiler 9 ft. 6 in. dia. and 10 ft. long, built for 90 lbs. pressure, will also be supplied. The coal bunker capacity is 1,500 tons, including the reserve bunker. An electric plant with a capacity of 100 16 c. p. lights will be supplied, and the vessels will be well equipped in every respect. They have been designed to carry 8,250 tons dead weight on a draught of 26 ft. at a mean sea speed of 10 knots per hour. In smooth water and under favorable conditions these vessels should be able to steam at the rate of about eleven knots when fully laden.

Moran Bros.' Pacific Coast Yard.

Facilities for local steamer traffic afforded by the waters of Puget Sound, and the constantly increasing number of steamers plying thereon, have always stimulated the growth of small marine engineering establishments along its shores. And now a rapidly increas-

ing foreign trade, making its American terminus here, is creating a demand for facilities for building and repairing ocean-going vessels.

The most important marine engineering plant at present on the Sound is that of Moran Bros. Company, situated at Seattle. It is the outgrowth of a small repair shop established here in 1881 by the Moran Bros., and it has steadily advanced till it now occupies a foremost position among marine engineering establishments in the Pacific Northwest. The shops and yards cover an area of fourteen acres, having a frontage of 700 ft. on Elliott Bay. The buildings, which are mostly of wood, include machine shop, pattern shop, foundry, blacksmith and boiler shops, as well as pipe, copper and other auxiliary shops, necessary for a complete marine engineering works. They are all fairly well equipped for the construction and repair of moderate sized vessels, particularly the foundry, which has overhead traveling cranes, and can handle good sized work, as, for example, the centrifugal pumps built for the United States Government dry-dock at Bremerton, Wash. Each of these pumps has a capacity of 110,000 gallons per minute, against a head of 28 ft., the discharge nozzle being 42 in. dia. The boiler shop is equipped with pneumatic caulking and riveting tools, and has bending rolls which can handle plate 10 ft. wide by 1 1-2 in. thick.

In the yards both steel and wooden hulls are constructed, an abundance of the finest kind of ship timber making facilities for the latter a necessity. A marine railway, which can haul out ships of 1,000 tons, is at present the only docking equipment.

One of the largest orders ever filled by this concern was for twelve stern wheel steamers for the Yukon river trade, which at the time of their completion, a year ago, we described and illustrated. Their main dimensions were: Length, 175 ft.; breadth, 35 ft.; depth, 6 1-2 ft. They were all alike, and rested on the same launching ways, the direction of launching being sidewise. Each steamer was equipped with engines having cylinders 20 in. dia. by 7 ft. stroke. The total time of construction of the whole fleet, including machinery, was five months. Another important contract completed by this firm was the construction of the United States torpedo boat *Rowan,* which has lately been accepted by the Government, and is shown in the accompanying illustration. Her maximum trial speed was 27.2 knots per hour. At present Moran Bros. are building their forty-eighth vessel, a steel tug-boat 128 ft. long, for the Puget Sound Tug-boat Co. They also have a smaller steel tug-boat under construction for other parties.

The present plant has, however, proved too small for increasing business, and new shops and yards are now in course of construction. As much of the hull work will be of wood, a large saw-mill has been erected, and is nearly ready for operation. In this they expect to manufacture from the log all the lumber needed for the yard, not only for the hull proper, but for all such work as deck-houses, with furnishings, sashes, doors; all woodwork required for a complete ship. This mill is placed near the yard, yet far enough away as not to endanger it or the shops in case of fire. It will run steadily; the surplus product will be placed on the lumber market, and the refuse, waste and sawdust will be used as fuel in the yard boilers, making a very economical arrangement.

The new shops will be driven by electricity, from a central station placed near the mill, and electrical distribution of power will be used as far as possible. These new shops are now in course of erection. One building, 96 ft. wide and 700 ft. long, is to contain the machine shop, foundry and blacksmith shop, overhead cranes, having a clear span of 36 ft., traversing the entire length of the building. The tools on hand will be transferred to the new shop, and many new and larger ones added. A 6,000 lb. hammer is now being placed in the new shop, and a 24 ft. plate planing machine in the yard.

The water front is to be remodeled, so as to give a total wharf front of 4,000 ft. A floating dry-dock 400 ft long, in two sections, is to replace the marine railway. Each section will be 200 ft. long, and small ships can be docked with one section. This dock, in conjunction with a new 75-ton crane, will provide for docking and repairing any ship now on the coast.

The new plant is to be equipped throughout with all modern appliances, and will be large enough to build and repair either steel or wooden ships of large tonnage.

The officers of the company are: President and general manager, Robert Moran; Trustees and also stockholders, William Moran, Frank Moran, and Sherman Moran. The growth of the place from a small shop to its present dimensions is mainly due to the perseverance and energy of its President, Robert Moran.

New Ship Yard at Camden.—Work is being pushed on the fitting out of the new ship yard at Camden, N. J., established by the New York Shipbuilding Company, of which Henry G. Morse is president. This company was organized last March, and subscriptions amounting to $3,000,000 were received from stockholders residing in New York, Philadelphia, Wilmington, Baltimore, Pittsburg and Youngstown, O. The board of directors consists of Henry G. Morse, Woodburn, N. J.; H. Walters and W. Jenkins, Baltimore, Md.; A. W. Melton and James H. Lockhart, Pittsburg, Pa.; M. C. Wick and J. Craig Smith, Youngstown, O. The Treasurer and Purchasing Agent is Charles S. Hall, and the Superintending Captain W. G. Randle, formerly of the American Line. Aside from the President, Henry G. Morse, the other officers have not been elected. The yard has been located at Camden, N. J., opposite Philadelphia, where the company has purchased 120 acres, having a frontage of two-thirds of a mile on the Delaware River and a depth of 1,500 ft. from the pier line at the narrowest point. The property is unobstructed by streets or railway lines. There is ample depth of water, the depth at the pier line being 40 ft. at low tide and 46 ft. at high tide along the entire water frontage, and directly in front the ship channel is 2,000 ft. wide. The plant was laid out by Mr. Morse, and on July 3 active field work was begun. Contracts for preliminary work and equipment to the amount of $1,200,000 have been made. The yard is being laid with a view to the construction of ships of all classes and sizes now built, and with sufficient capacity for any probable increase in size or requirements which may be demanded in the future.

At a preliminary speed trial of the torpedo-boat *Dahlgren,* built at Bath, Me., a speed of 29.75 knots was attained.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—VI.*

BY R. W. JACK.

In the case of a high-pressure engine, the superheating is effected by the dynamic action of the steam in the boiler, but the loss which this action might occasion is repaired by the evaporative power of the generator, and in effect neither increases nor diminishes its efficiency. Theoretically, it is not possible for steam to do work upon a piston without becoming condensed, so that even if the full pressure were carried to the point of cut-off there would invariably be an equivalent weight of water to the amount of work performed. If, on the other hand, the steam expands without doing external work in the transmission of energy, then, since the total quantity of heat (if I may be allowed to use the analogy) remains constant, and with it the total quantity of work which it is capable of performing in expanding to a still lower pressure, the power must be exerted under a combination of two different conditions, one—as by the expansion of pure steam following the law of condensation, and the other—conforming to the laws of fixed gases while the steam remains superheated. We believe in the conservation of energy, and we must, therefore, conclude that the superheating of steam in this way by steam of a higher pressure cannot be shown to be either loss or gain. Loss of pressure by wire-drawing of the steam is a direct loss of power in the first instance, and though we are led to expect an equivalent addition of heat, it is not energy exactly, in the form which we desire. Experience would seem to teach that the less the free action of steam is interfered with during its expansion, the greater the efficiency of the system. In order that the steam line of an indicator diagram may not be unduly lowered towards the point of cut-off, a certain ratio must be observed between the rate of change of volume and the area of opening to steam. A convenient rule for the area of opening to steam is $a = \frac{A\,s}{10000}$ where a is the area of opening, A the area of cylinder in square inches, and s is the mean speed of the piston in feet per minute (2 stroke × revolutions per minute).

Marine engines invariably are so fitted that the distance through which the steam may be carried can be adjusted within certain limits. With special valve gears and with separate cut-off valves the range is much greater than with the common link motion. In any form of valve gear, however, the point of cut-off will have very little influence on the direction of the steam line of a diagram, because in extending the point of cut-off, or inversely in increasing the expansion, the effect is usually obtained by simply reducing the motion of the valve, thereby decreasing the area of opening to steam and the speed of the piston is nearly the same proportion.

The most interesting and instructive line of the diagram is the expansion curve. When the valve closes to steam the nature of the curve described by the indicator is subject to so many possibilities that we must be guided in our conclusions by what we already know as to the mechanical state of the engines quite as much as by the theoretical conditions of ideal expansion. In all cases, then, it is well to begin our study of this line of the diagram by a reference to that which would be traced without any interference with the action of the laws relating to the expansion of a perfect gas. It has been shown how this curve may be drawn either graphically or the points in the curve located by a simple calculation. If the ideal curve be drawn through the point of cut-off, it will be found almost invariably to fall below the line traced in the indicator. The extent of the difference between the two lines will depend on various conditions. If we know that the slide valve and piston are absolutely steam-tight, the difference between the two lines arises from the fact that during expansion a certain amount of the water of initial condensation becomes re-evaporated.

In text books, and indeed in most papers which treat of the liquefaction of steam in a cylinder, the prevailing idea seems to be alternate heating and cooling of the piston and cylinder walls, on the admission and eduction of the steam. To practical men, however, this does not seem to be a very practical view of the case. Since the alternations are so rapid and the conductivity of iron so comparatively slow, this theory can scarcely coincide with the actual state of affairs. It may be more correct to conceive of the mass of the cylinder at some temperature intermediate between those due to live and exhaust steam, while the motion of the piston itself should tend to equalize, and by its friction to elevate the mean temperature of the mass of metal. In this view of the case it is thus easier to comprehend the process of liquefaction and re-evaporation, and the extent of the action will therefore depend on the difference between the temperatures of steam of initial pressure and that due to back pressure. In other words, the greater the amount of expansion allowed in a cylinder and the fewer the alternations, the greater becomes the difference of temperatures and the larger the percentage of liquefaction and re-evaporation.

Re-evaporation in a cylinder can never exceed, and in ordinary practice seldom equals, the total condensation, for besides the condensation which arises inside the cylinder, the condensation which must take place between the boiler and the cylinder by radiation from steam pipes and connections, and that which is due to the abstraction of heat in the performance of work should also be considered. The loss of work or energy possessed by the initial steam is thus to be referred not only by the processes herein mentioned, but also to the fact that water being a better medium for the transmission of heat, the loss occasioned by radiation from the body of the cylinder is still further aggravated. The space between the ideal curve and the actual curve of the indicator diagram will, therefore, show only a certain proportion of the total loss. The variations in the expansion curve of an indicator diagram which may be traced to mechanical defects are an abnormal increase in the pressure due to a leaky slide valve, a reduction of pressure due to a defective piston, or, as may be more common, a combination of the effects of both. It is only by the aid of the ideal curve that the prevalence of those defects and their extent may be made clear. If the point of cut-off cannot be precisely

*From a paper read before the Institution of Engineers and Shipbuilders at Hong Kong.

located, a point should be selected as near to it as possible on the expansion line itself and the ideal curve drawn through it. The clearance of the cylinder and the cubic dimensions or capacity of the steam ports should in every instance be ascertained, either by calculation or by filling the spaces with a known quantity of water. The cubic contents of the space occupied by the steam when the piston is at either extremity of its stroke is reduced to the same cross-sectional area as the cylinder, and the length thus found added to the length of the stroke. For instance, suppose that the diameter of cylinder is 20 in. and the amount of water required to fill the clearance and steam-ports is 3 1-8 gallons or 1-2 cubic foot = 864 cubic inches. Then 864 ÷ area of cylinder is $\frac{864}{314.16} = 2\ 3\text{-}4$ in. nearly, so that the origin of the curve must be shifted 2 3-4 in. beyond the extremity of the indicator card and on the perfect vacuum line. The length of the expansion curve may be altered to a limited extent by the method of linking up the common valve gear or by increasing the expansion with special valve gears.

In the case of an indicator diagram taken from the intermediate or the low pressure cylinder of a triple-expansion or compound engine, the nature of the steam line will depend on the points of cut-off, the volume of steam chest, the ratio of volumes of cylinders, and the relative positions of cranks. The effect of increasing the expansion by linking up is to increase the initial pressure on the piston, while the steam chest being of limited capacity, the steam line invariably falls towards the point of cut-off. The greater the capacity of the steam chest the less will be the fluctuations in the steam pressure, and if the steam ports are of ample area the more nearly parallel will the steam line be with the base or atmospheric line. The sequence of the cranks affects the steam line in the same way. For instance, if the cranks be so arranged that when the first engine begins to open to exhaust, the one next in series is just opening to steam, there will be less of a fall towards the point of cut-off. Generally speaking, the point of cut-off in the I. P. or L. P. cylinder of a triple compound engine decides the mean pressure only, while the nature and direction of the steam line depends mainly on the considerations already noticed.

The exhaust line is very seldom a cause for complaint. The position on an indicator card at which the valve opens to exhaust is determined by the difference between the external or steam lap and the internal or exhaust lap of the valve. If those laps were equal, then the opening to steam on the one side and the opening to exhaust on the other would occur at the same position of the piston. The closing to exhaust on the one side would also take place at the moment of closing to steam on the other, but this condition will be easily seen to be opposed to the best practice, for in the case of an engine with an early and fixed cut-off the compression would become too great. In marine engines the usual plan is to have as little exhaust lap as possible, just enough to insure that the ends of the cylinder shall not communicate through the valve. But even this practice is sometimes reversed and the valve is given a small amount of negative lap (i. e., the exhaust edges of the valve do not cover the steam ports in the cylinder face when the valve is in mid-position), in order to fill that end of the cylinder in which compression is about to take place with steam of higher pressure. The opening to exhaust will, therefore, usually take place when the valve is about the middle of its travel, that is, when the valve is moving at its greatest speed. At the same moment the piston is approaching the dead center and is moving very slowly, so that it is principally due to this circumstance that the exhaust line is in most cases satisfactory.

The back pressure line depends to a great extent upon the same considerations as those which govern the steam line of the engine next in series. If the diagram be one taken from an L. P. engine exhausting to a condenser, or from any simple expansive engine, the back pressure is, as a rule, more constant, because in such a case it is independent of those conditions which determine the back pressure line of a H. P. or I. P. engine in a series. The capacity of the steam chest itself is subject to variation, for it should be remembered that the volume of the cylinder which, at the moment of opening to exhaust, must be added to the total volume, decreases as the piston returns to the opposite end of its stroke. The result is that the back pressure line of that engine is more nearly uniform than it might otherwise be owing to this contraction of the total space which the steam occupies at the instant of opening to exhaust. We have seen that the position on a diagram where the exhaust closes and the compression begins is governed both by the steam lap and by the exhaust lap of the valve. The steam lap decides the angle between crank and eccentric, and therefore the relative position of piston and valve. Exhaust lap and the position of the valve determine the position of the piston where compression begins, that is, the exhaust lap, to produce compression in a cylinder, can only modify the action of the valve, since its position is already fixed by the steam lap or expansion to be allowed in the cylinder. The point of closing to exhaust is, therefore, primarily dependent on the point of steam cut-off, and it is hastened by adding internal lap. It will follow that if by any means we alter the expansion in a cylinder, such as by linking up, we correspondingly change the compression. The nature of a compression curve follows the same laws as those under which the expansion curve is generated and is liable to the same defects. The total clearance of space occupied by the steam when the piston reaches the end of its stroke is the main factor in the determination of the compression curve when it exists. Let us suppose that the total clearance at one end of the cylinder is to be equal to 3 in. in the length of the cylinder capacity. Then, if the exhaust closes 3 in. before the end of the stroke, the space occupied by the steam at the moment of closing to exhaust is (3 + 3) equal to 6 in. in the length of the cylinder.

We will also suppose that the pressure of steam at the moment of closing to exhaust is 75 lbs. per sq. in. absolute. To find the pressure to which the steam will rise by compression we need only apply the rule we have already given, viz., P × V = a constant, so that if P + V = 75 × 6 = 450 when compression begins, the pressure at the extremity of the stroke will be $\frac{150}{3} =$

150 lbs. per sq. in. absolute according to Boyle's law, i. e., if the space be reduced by one-half the pressure is doubled. Upon this supposition we may construct the complete curve in the same way exactly as we have applied it in the construction of the ideal expansion curve. All that is necessary to be known is the volume of the steam ports and the clearance of the piston in the cylinder, the distance of the piston from end of its stroke when the valve closes to exhaust, and the absolute pressure of the steam at that moment. We thus may see that an ideal compression curve may be traced if we know beforehand the total clearance at the end of the cylinder, and conversely if the actual compression curve of a diagram is at all uniform, we may locate its origin, and thereby find approximately the total clearance in terms of the length of cylinder which gives the same cubic capacity. In Fig. 16, *AB* is the atmospheric line, *CD* is the line of perfect vacuum, drawn parallel to *AB*, and about 15 lbs. below it to the same scale as the diagram. Select two points *a* and *b* on the compression curve as far apart as possible, only making sure that they are included in the curve. Complete the parallelogram *a c b d*, by drawing the horizontal lines

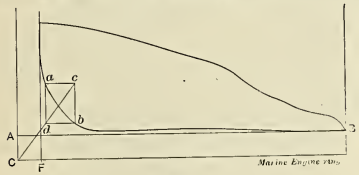


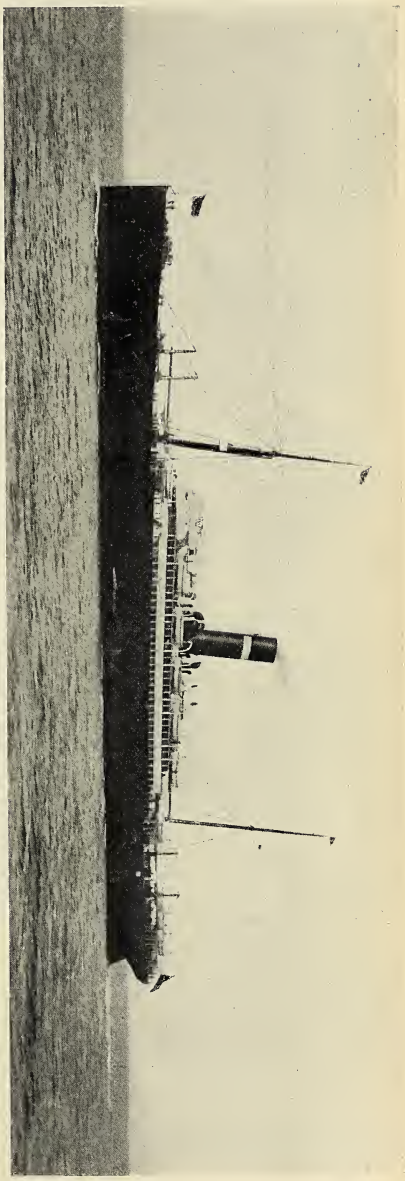
FIG. 16.

a c from *a*, *b d* from *b*, and the vertical lines *a d* from *a*, *b c* from *b*. Through *c d* draw a straight line, and produce it till it cuts the perfect vacuum line in the point *C*. Then *C* is the origin of the curve, and the length *CE*, beyond the length of cylinder *ED*, measures the total clearance in the same way that *ED* measures the cubic contents of the space swept by the piston. Measure *CE* to the same scale as *ED*, and state the terms in proportion, thus:

Total clearance: Space swept by piston :: *CE* : *ED*, or we may simply multiply the area of the piston by the length *ED*.

In those engines which have a separate cut-off valve, a too early exhaust or an excessive compression can be avoided to a greater extent, for the actual cut-off being effected by the expansion valve, the steam cut off by the main slide valve may be made to take place much later in the stroke, less steam lap is required, and consequently the effect produced by the angular advance of the eccentric, which has been shown to be mainly accountable for the position at which the exhaust closes, is proportionally modified.

A close estimate of the number of first and second class passengers who have left New York on transatlantic vessels since the beginning of May last places the number at 40,000, and the total of fares paid between $15,000,000 and $16,000,000. The great increase in the volume of travel is accounted for largely by the diminished travel last season, due to the Spanish war.



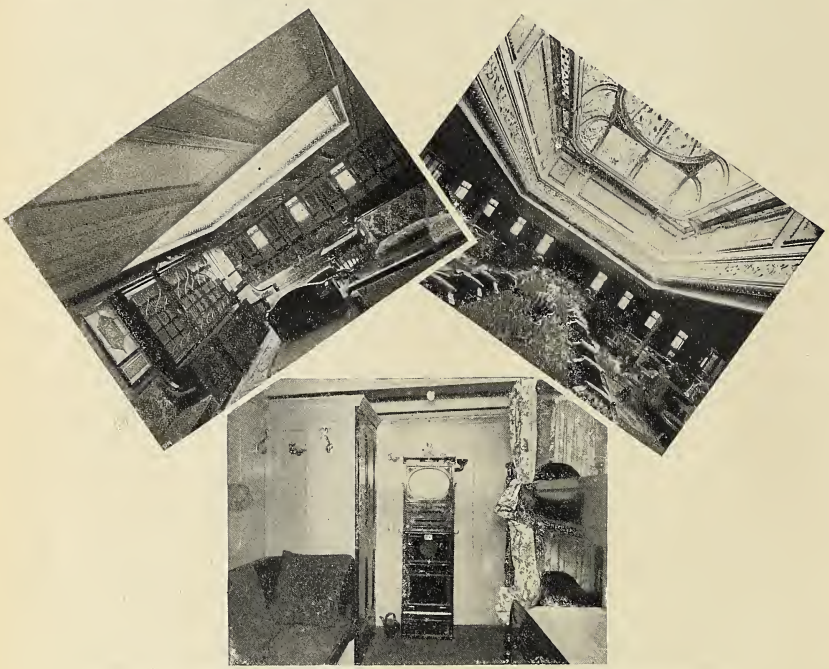
TWIN SCREW STEAMSHIP NEW ENGLAND, 12,000 TONS, ON THE BOSTON-LIVERPOOL ROUTE OF THE DOMINION LINE—FOR DESCRIPTION SEE PAGE 74.

S.S. NEW ENGLAND, A TRANSATLANTIC LINER OF THE INTERMEDIATE TYPE.

A splendid example of the modern and growing "intermediate" type of liner is the Dominion Line mail steamer *New England*, now sailing on the Boston and Liverpool route of the company. This boat, a product of the famous Harland & Wolff yard, has become very popular with the traveling public and of great interest to shipowners, so a brief description, with photographs, will be of general interest.

The dimensions of this fine vessel are: Length, 565 ft.; beam, 59 ft. 3 in., and gross register tonnage nearly 12,000 tons. She has accommodations for 500 first and second cabin passengers and for 800 in the steerage. She is in fact one of the very largest vessels afloat carrying all classes of passengers. The poop on the after section has been entirely set apart for steerage passengers. They have a dining saloon 80 ft. long and 18 ft. wide in which there is a piano, and from this room there is an inside stairway leading to a spacious smoking room on the upper deck aft.

The first cabin accommodation is luxurious. The grand saloon, which is on the upper deck, has seating capacity for 200, and is beautifully decorated in lincrusta panels with satin wood facings, and is artistically picked out and relieved with gold. Over the saloon there is a glass dome, brightly colored and emblazoned with coats of arms and heraldic devices. The library, situated on the promenade deck, is fitted up in unique style. The walls are beautifully paneled in satin wood of different shades, each panel containing a carved figure of some poet or writer, and the New England States are also represented by their richly cut coats of arms. The furniture is Chippendale and the upholstery is flowered electric-blue plush in harmony with the other decorations. The "Lounge," situated on the same deck, is forward of the grand saloon. It surrounds the saloon dome and has a deck laid in parquetry, covered with rich and costly Turkish rugs. A beautiful effect is obtained by the colored glass dome panels, which softly illuminate this resting place. There are four spacious promenade decks, each 186 ft. long and 17 ft. wide, set apart for the saloon passengers.



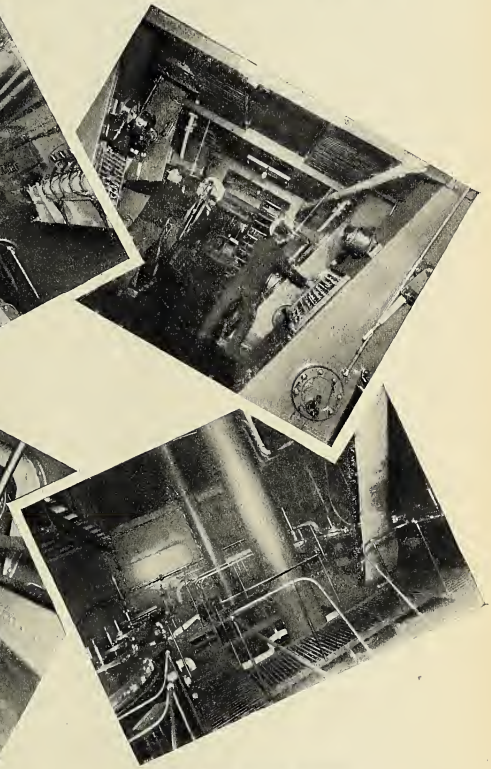
Library on Promenade Deck. *First-Class Cabin.—Two Berths.* *Main Dining Saloon.*

The *New England* is a twin screw ship, fitted with triple expansion balanced engines, with cylinders 30 in., 50 in. and two 58 in. by 54 in. stroke. They are of 8,700 I. H. P., and are supplied with steam, at 180 lbs. pressure, by three double-ended and three single-ended Scotch boilers. These have a total grate surface of 665 sq. ft., and burn about 180 tons of bituminous coal

per day under natural draft. In the engine department there is a very extensive installation of auxiliaries, including the various independent pumps, feed water heaters, filters and evaporators, also electric light and refrigerating machinery.

The hull construction of the vessel is very strong and conforms to the requirements of the highest class of Lloyds. She has a double bottom with a capacity of 1,700 tons of water ballast, and has four continuous steel decks and nine water-tight bulkheads.

Thrust Block Recess in Engine Room.
One of the Shaft Alleys.



Standing By on Starting Platform.
Top Platform in Engine Room.

STEAM DREDGES.—Two powerful twin screw steam dredges have been built by William Simons & Co., Renfrew, Scotland, for use in North China. The vessels are fitted with dredging apparatus of the bucket type, and also with centrifugal pumps which discharge on shore through piping the dredgings raised by the buckets. On trial, when running 18 buckets a minute, 1,050 tons of loose soil were raised per hour, and when dredging in harder material at the rate of 12 buckets per minute 450 tons of soil were raised per hour. On the measured mile these vessels attain a speed of about eight knots.

METHOD OF STRENGTHENING COPPER STEAM PIPES LONGITUDINALLY.*

BY T. MESSENGER.

The question of strengthening copper steam pipes is one of considerable importance, taking into consideration the high pressures now used. In past times, when low pressures were used and lighter pipes were necessary, the longitudinal brazed seams could be more satisfactorily made by means of the carefully brazed dove-tailed lap system, as shown in Fig. 1, than is now made by the brazed lap seam without dove-tailing. The writer is of the opinion that, were it not for the much greater expense involved in making the dove-tailed lap joint in dealing with the greater thickness of the material necessary, the old system would still be preferable in making a stronger and more reliable joint.

In either case brazed seams will be undoubtedly strengthened by means of some system of bands or

*Paper read before the North east Coast Institution of Engineers and Shipbuilders, England.

straps placed round the pipes at suitable intervals, and should any defect develop in a particular part of the joint the effects of such bands will be to confine the defect locally and prevent the danger of a long rent, and possibly disastrous consequences. Several methods of strengthening pipes are in use, such as binding them

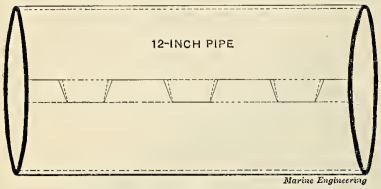


FIG. 1.

with a continuous coil of wire from end to end, placing separate bands of wire at intervals, the wire being shrunk on by heating and the ends of the wire joined by twisting them together, and occasionally hoops have been used, secured by means of lugs and bolts. The writer having had occasion to deal with pipes of considerable size, and for which it was necessary to obtain a higher factor of safety, has adopted with success the system herein described.

This consists in fitting round the pipe, as shown in Fig. 2, a series of bands of wrought iron or other suitable material, and placed at intervals of, say 6 in. apart.

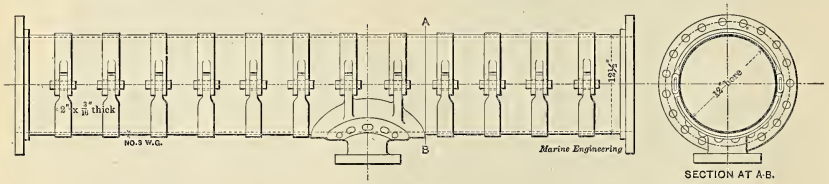


FIG. 2.

In the example shown the copper pipe was 12 in. dia. and No. 3 W.G. thick, and had been twelve years in use, subject to a working pressure of 110 lbs. per sq. in., when it began to show defects. The bands fitted were each made in halves, each half being secured to the other by means of cotton passing through single and double-eyed joints. The bands were placed 6 in. apart between centers, and the section of the flat parts of same was 2 in. by 3-16 in., and the strength of the parts at the joints and cotters was made 10 per cent in excess of other parts. The original factor of safety by Board of Trade rule was 11.3, and after fitting the bands this was increased to 15.7, or nearly 40 per cent more, which was considered sufficient in this particular case. It will be noticed, on referring to the figure, that the pipe in question has a branch, and it will be seen how conveniently such bands can be adapted and fitted around the flanges of branches, and so materially strengthen the main pipe.

The cotters used in fixing the separate halves of the bands together, on being inserted in the eyes of the single and double ends, are fixed in place by means of a special tool, Fig. 3, which has vise-like jaws. The use of this tool enables the cotters to be gently forced into position without having to use either part or the

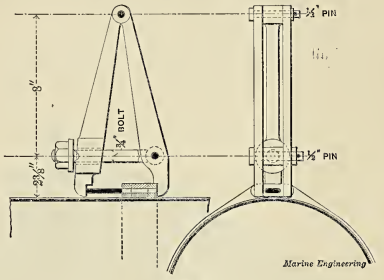


FIG. 3.

hammer for tightening up, and it can also be used for removing the cotters when necessary for repairing or testing the pipes. The bands can by this means be secured to the pipes when the latter are in place or otherwise. In strengthening pipes where bends occur the section of the band is made round, as shown in Fig. 4.

Although in new work steel or iron pipes are now being used, there are a great number of vessels having existing copper steam pipes which may require strengthening, owing to their becoming weakened by age, and in such cases these bands can be easily applied.

In the case of copper pipes the increased temperature due to the high pressure, causing a reduction in

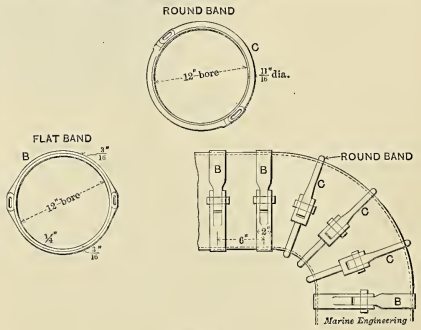


FIG. 4.

strength of the material, may render additional strengthening by such means desirable.

INSTANTANEOUS PHOTOGRAPH OF THE FAMOUS OLD GUION LINER ALASKA, TAKEN WHEN SHE WAS ENTERING THE PORT OF NEW YORK.

Memories of the great record smashing period of the eighties are recalled by the announcement that the old Guion liner *Alaska* has been sold on the Clyde to be broken up. Those who knew the ship only by reputation, alike with those who knew her from personal observation, must have a feeling of regret, strange perhaps in connection with an inanimate object, but none the less real. There is, however, something almost animal about such a ship which finds a response in any nation possessed of the racing spirit. In her day the *Alaska* was the best known vessel afloat, and her name will ever be prominent in the annals of steam navigation. She was the first ship to make the transatlantic voyage within seven days. As will be observed from an inspection of the accompanying photograph, the *Alaska* was an unusually handsome vessel, four masted, barque rigged, and with two funnels of good proportions. She did not look bulky, although for the period a large vessel, and in fact it was often said of her that "she did not look her size."

The *Alaska* was built at the Fairfield yard on the Clyde from the designs of William Pearce, who a short time before had turned out the wonderful *Arizona*, also for the Guion line. It was the success of that vessel indeed which induced the Guions to build the larger and more powerful *Alaska*. As a matter of record we give here in detail the dimensions, etc., of the *Alaska*. Length, l. w. l., 500 ft.; beam, 50 ft.; depth from main deck, 38 ft.; gross tonnage, 6,932 tons; under decks, 6,586 tons; net, 3,554 tons; displacement at load draught of 21 ft., 9,210 tons; block coefficient, .614; mid section coefficient, .904. She was fitted with three cylinder compound vertical inverted engines, with high pressure cylinder, 68 in. dia. and two low pressure cylinders 100 in. dia. and 6 ft. stroke, with cylinder ratios of 1 to 4.32. According to the then prevailing practice the high pressure cylinder was set between the two low pressure. The I. H. P. was 10,500, and on trial the *Alaska* is said to have reached a speed of 18 knots. She was fitted with nine Scotch boilers, 15 ft. dia., having six furnaces each and a total of 1,242 sq. ft. of grate surface. They were built for 100 lbs. working pressure. She was, of course, a single screw vessel with a four bladed propeller 23 ft. dia. and 34.6 ft. pitch.

The *Alaska* came out in the month of November, and after leaving Queenstown on her maiden trip she ran into a hurricane and the steam steering gear gave out and later the emergency hand gear broke down, causing a delay of ten hours. Another delay was caused on the trip by the breaking of a small steam pipe, which drove the engineers out of the engine room for a time. For some reason a full head of steam was not maintained, but in spite of this she averaged 16 knots in the trip across, and her best day's run was 402 knots. She continued doing better, and in 1882 she reduced the time of her eastward passage (New York-Queenstown) to 6 days, 18 hours and 37 minutes. The following year she cut down the westward passage (Queenstown-New York) to 6 days, 21 hours and 40 minutes, proving herself to be the then fastest steamship afloat. Her popularity was tremendous, and her sailing list during the season was always filled.

The *Alaska* had seven decks, the first or promenade deck extending the entire length and breadth of the vessel, except for the spaces at the ends occupied by the "turtle." On this deck according to the prevailing custom the boats were carried. The next deck was open at the sides and on this were the officers' quarters and accommodations for second cabin passengers. On the next or main deck the saloon accommodation was located. The dining saloon was 50 ft. wide, 64 ft. long, and had a seating capacity for 280 passengers. At the sides the ceiling was 9 ft. high, and in the center 20 ft. high. On the fourth deck the steerage passengers were berthed, and below the spaces were used for cargo. The *Alaska* had accommodation for 340 cabin, about 100 second cabin, and 1,100 steerage passengers. She was fitted with all the latest improvements of her time, including electric lights and call bells.

So successful had been the *Arizona* and the *Alaska* that the Guions decided to build another and yet larger vessel, the *Oregon*, also a product of the Fairfield yard. She came out in 1883 and successfully lowered the *Alaska's* record, but the company had already become involved in financial difficulties and the *Oregon* passed into the possession of the Cunard line.

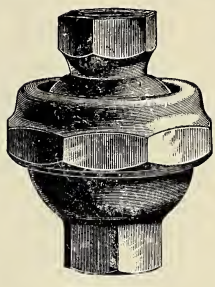
During one voyage the *Alaska* lost her rudder, but she was enabled to go ahead again by passing lines to a steamer which came up, and towing the assisting vessel instead of being towed. In this way both vessels reached New York safely. Captain George S. Murray was in command of the *Alaska*, and was a most efficient and popular officer; of his subsequent career we have no record.

After the Guion line went out of business in the early nineties the *Alaska* was laid up in the Clyde along with the *Arizona*, and we believe was not again in commission until 1896-7, when she was in the service of Spain as a transport, sailing under the name of the *Magellanes*. After a short career she was again laid up and probably did not receive any attention, as it was reported not long ago that she had nearly sunk at her moorings. In the light of present practice she was long since classed as a "coal eater." Her partner in the record smashing business, the *Arizona*, to which vessel the term "Greyhound" was first applied, is now doing fine service in the Pacific as a U. S. transport.

IMPROVED APPARATUS.

Moran Flexible Joint.

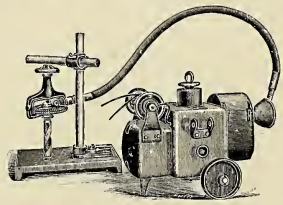
For use on steam mains, or in fact in any place aboard ship, where expansion and contraction of pipes is to be provided for, the Moran Flexible Joint is recommended by the manufacturers. The joint is very simple in construction, consisting of only three pieces, the bell or cup, the ball, and the ring for keeping the ball in position inside the bell. It is made without packing or springs and with a certain amount of looseness, and it becomes steam tight by the internal pressure bringing the spherical surfaces in contact with each other, holding them thus so long as any pressure is maintained in the pipes. The joint is manufactured also for specially high pressure work, running, so the makers say, as high as 2,000 lbs. per sq. in. The joint is manufactured by the Moran Flexible Steam Joint Company, 149 Third street, Louisville, Ky.



MORAN JOINT.

Portable Plant for Drilling.

For emergency work on ship board a specially useful tool is the combination of Stow Flexible Shaft and Multi-Speed Electric Motor. The motor is of the iron clad type, practically dust proof, and water proof, and with its case is carried on an axle and two wheels, so that it can be readily moved about. A special feature of the machine is the facility with which the speed can be changed within a wide range. This is accomplished by the gradual withdrawal or insertion of a plug of soft iron in the field magnet core, thereby varying the intensity of the field magnetism. This dispenses with the usual more or less complicated speed regulator. The standard motors are built for 110, 220 and 500 volt circuits, but they can be built on order for any practical voltage. They are of very simple and durable construction and are guaranteed to carry, for a short time, an overload of 50 per cent. The machine can be placed in position close to the work and connected with the nearest electric ship circuit without any delay. The flexible shaft can be used to operate a

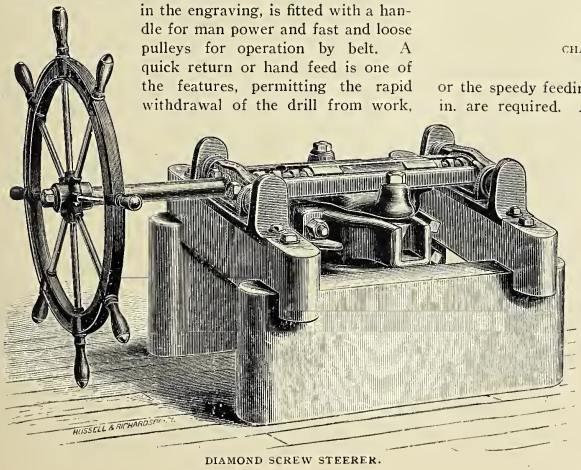


STOW PORTABLE DRILLER.

breast drill or drill press, or for the purpose of reaming or tapping holes. The sizes usually stocked cover a range for drilling holes from 1-2 in. to 2 in. dia. The combination is manufactured by the Stow Manufacturing Co., Binghamton, N. Y.

Diamond Screw Steerer.

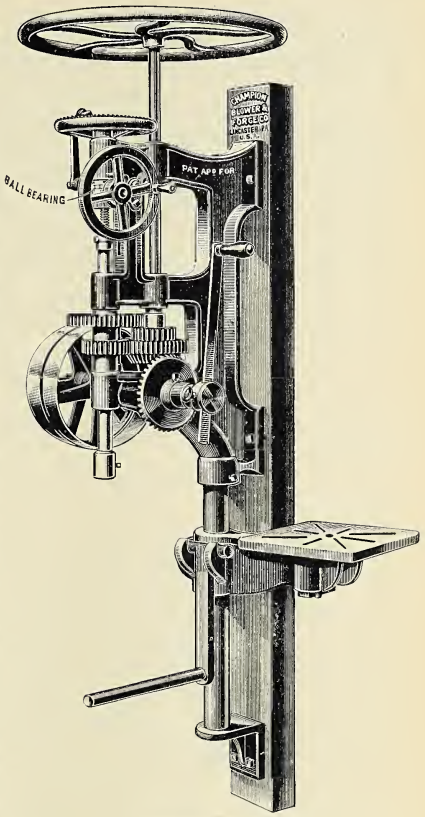
The Reed Patent Diamond Screw Steerer, manufactured by the Lockwood Manufacturing Co., East Boston, Mass., is one of the most popular steerers used on the seaboard or lakes. It is powerful, quick acting, and locks in any position. All shocks are received on rubber buffers, relieving the working parts of any sudden strain. It is simple, compact and durable, and can be taken apart and set up by anyone with ordinary tools found aboard ship. It consists of a strong steel shaft, having a right hand and left hand thread of suitable pitch, cut so that the threads cross each other, leaving a diamond shaped thread at their intersection. On each side of this shaft are long traverse nuts, a right hand thread on the port side and left hand thread on the starboard side. These nuts are guided by heavy steel bars and have on a projecting arm, steel studs fitted to a sliding block on the lower side, by ball and socket joint. These blocks slide in a wide, deep guide, planed on each side of the hoop casting on the rudder head. By this construction there is entire freedom of motion, and to cramp the gear anywhere is impossible. This steering gear can be applied to an iron rudder stock as well as to wood, and with a disconnecting attachment not shown, makes an ideal auxiliary steering gear. It is made in nine sizes to suit wood rudder heads from 4 in. to 20 in. dia. All parts are made to gauge and spare parts can be supplied promptly by the makers.



DIAMOND SCREW STEERER.

Hand and Power Drill.

A new form of post drill for hand and power use has been brought out by the Champion Blower and Forge Co., of Lancaster, Pa. This machine, as shown in the engraving, is fitted with a handle for man power and fast and loose pulleys for operation by belt. A quick return or hand feed is one of the features, permitting the rapid withdrawal of the drill from work, or the speedy feeding of the drill when sizes under 1-2 in. are required. A ball bearing is used which, it is claimed, effects a considerable reduction in the amount of power absorbed by the machine. The machine is made with double, cut, gears, so that a range of speed for light or heavy work can be secured. The machine illustrated, No. 7, drills to the center of a 19 in. circle. The spindle usually takes in a 41-64 in. straight shank, but can be bored for 1-2 in. shank if required. The speed for ordinary work is 180 revolutions per minute, and the weight of the machine complete is 325 pounds. This apparatus is specially adapted for use in the machine shop on board a steam vessel.



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SEA speeds of steamships have a special interest for American engineers, for it is in the transatlantic trade, chiefly, that this feature of steam navigation has been developed. Not exclusively so, however, and in these days of high speeds it is well to recollect the achievements of American engineers, in this direction, in the past. Leaving out of discussion vessels of the torpedo type and including only commercial ships and seagoing naval vessels, one frequently hears exaggerated statements about the actual progress in the matter of speed. Considering the item of speed alone, it is a fact that, on the contrary, there has been an increase of only about six knots in more than thirty years. In the year 1868, when the highest rate of speed on the Atlantic was about 14.5 knots (*City of Paris*, British, and *Ville de Paris*, French), B. F. Isherwood, engineer-in-chief of the United States Navy, brought out the cruiser *Wampanoag*, which attained a maximum speed of 17.5 knots, and a sustained speed of 16.75 knots at sea. During the first twenty-four hours of her trial trip she logged 405 knots. This performance was so far in advance of the then best on record that it actually caused adverse criticism, which finally resulted in the vessel being laid up and neglected. She was eventually sold, in the year 1885, for a nominal sum. Compared with the standard practice of the time this vessel was no doubt a great innovation, and her machinery equipment was so extensive that the interior arrangements were doubtless unacceptable to the sailors of the day. As a commerce destroyer, however, for which purpose she was built, her fitness cannot be questioned. A sister ship, the *Ammomoosic*, brought out about the same time, also showed a phenomenal speed, and for reasons similar to those which decided the fate of the *Wampanoag* she was allowed to fall into decay. These ships were of about 3,300 tons (old measurement) and were fitted with horizontal direct-acting geared engines with surface condensers. The speed of 17 knots was attained on a coal consumption of five and three-fourths tons of coal an hour. The extraordinary performances of these ships can be better appreciated when it is remembered that at the time the fastest ships in the British Navy were only capable of a speed of 14 knots. In fact, the performances of these two United States warships remained unequalled more than ten years, when the Guion liner *Arizona* lowered the Atlantic record. From the early eighties to the present day there has been a steady advance in speed both in merchant and naval ships, until now we have the U.S.S. *Minneapolis*, with a record of 23.073 knots; the Germans have the transatlantic liner *Kaiser Wilhelm der Grosse*, which lately maintained an average of 22.62 knots on the eastward passage; and the British have the mail steamers *Ulster*, *Munster*, *Leinster* and *Connaught*, with a daily sea speed of 23 knots. There is one very simple reason why a slight increase in hourly speed causes what might be called a disproportionate result in the success of a transatlantic liner—a reason that is sometimes lost sight of. Owing to the duration of the voyage —the great distance traveled—a small though uniform increase in hourly speed means a considerable fraction of time in the aggregate. Taking the New York-Queenstown trip as 2,900 nautical miles, this can be covered by a 20-knot boat in 6 days, 1 hour, while a boat averaging 20.5 knots will perform the passage in about 3.5 hours less time. In the case of a short sea passage, as in coast or across channel trade, while the proportionate difference would be as great, the actual difference would be so slight as to escape ordinary notice. In a 60-mile trip, for example, the difference in time of passage of two such boats would be (roughly) only five minutes. Though high sea speed has been attained in special service, it must not be supposed that the records prominently reported now and

again are indicative of the speed usual in the merchant service. In Lloyds' list there are only forty-three merchant steamships of all nationalities classed as having speeds of 20 knots and upwards, and several of these are cross-channel paddle steamers. It is not in speed, however, that the most striking advance has been made, but in the directions of efficiency and economy. The proportion of effective horse power to tons weight of machinery has grown very considerably, or looking at the displacement side of the matter, weights have been cut down about one-half. In ordinary mercantile practice to-day, we can get 9 or 10 indicated horse power per ton of machinery, while in those days 4 to 6 indicated horse power was usual. Coal consumption, measured by indicated horse power, has been more than cut in two, boats of to-day running on a consumption of 1.5 pounds of coal per indicated horse power per hour, whereas 3 to 3.5 pounds was the average 30 to 40 years ago. In the future, too, it is not unlikely that greater progress will be made in these directions than in speed, though, of course, the latter in great measure depends upon the former. Engineering considerations alone, however, do not govern, for they are secondary to commercial considerations in mercantile marine construction, which is in fact a most elaborate series of compromises.

IN another place in this issue we publish the report made by Captain Frederick Watkins of the steamship *Paris* to the U.S. Board of Supervising Inspectors at New York, in which he takes unto himself the entire blame for the mishap. Upon this statement the Board, after deliberation, has found Capt. Watkins guilty of negligence and suspended his license as master for a period of two years. This sentence seems to be a severe one judging from the published record of the proceedings, but doubtless the board acted upon its best information and belief. No lives were lost in the mishap, nor indeed was any person injured, and this might be advanced as a reason for leniency, taking account also of the splendid previous record of the unfortunate commander. If we are not mistaken, no heavier sentence was imposed upon Capt. Williams, of the liner *Atlantic*, who lost his vessel and 500 of those on board on the coast of Nova Scotia in March 1873. It is very probable, however, that Capt. Watkins will feel the loss of his ship far more keenly than the temporary loss of his certificate. It is often said of transatlantic captains that it is only a question of time when they will get into trouble at sea, which although not true, is a correct indication of the hazardous nature of their occupation. Since the mishap occurred there has been a good deal said about the necessity for some means of checking the calculations made by the captain in setting the ship's course. Theoretically this would work all right, but practically it might not. The captain of a ship is and must be responsible for the safety of the ship and all it contains, and there can be no division of duties without a similar division of responsibilities. If he is not competent to properly set the course of his ship he is not competent to be in command, no matter what may be the reason for his condition of incompetency. His attention and responsibilities alike must be undivided. It is related of a Cunard captain that he asked and obtained permission for his wife to accompany him on a trip across the Atlantic, but when he got down to his ship to take her out he found that he was entered as a passenger only and that another captain had been given command for that trip. Now that the *Paris* is safe in port again it is very probable that she will be put in condition for a prolonged period of usefulness. With a newer and more economical machinery equipment she would be really an improved vessel, and the staunchness of her construction, which has again been demonstrated in this mishap, will be recognized by the discriminating traveler.

SHIPBUILDING and ship owning statistics compiled by Lloyds show the total merchant tonnage of the British Empire to be nearly 14,000,000 tons, of which 11,719,247 tons is steam tonnage. The second place is held by the United States with 2,465,387 total tonnage, and Germany is a close third with 2,453,334 tons. The other maritime nations follow at a considerable distance; from Norway with 1,694,230 tons to Portugal with only a little over 100,000 tons. Spain is credited with 608,885 tons. In ships with a tonnage of 10,000 and upwards, Germany takes the lead, having twenty steamships in this class, and the United Kingdom comes next with nine only. Taking account of vessels of 5,000 tons and upwards, however, the United Kingdom leads with a total of two hundred and fifty, and Germany second with fifty. The United States has now only three.

MARINE BREAKDOWNS AND LOSSES.

LOSS AND SUBSEQUENT RECOVERY OF THE AMERICAN LINE STEAMSHIP PARIS.

After lying on the Manacle rocks for more than fifty days, the American Line steamer *Paris* was safely floated by the salvors on July 11, and was later towed into Falmouth Harbor. It was on Sunday morning, May 21, that this fine vessel went ashore while westbound from Southampton, via Cherbourg, France, to New York. She had 386 passengers on board and was proceeding at the usual rate of speed, when, without warning, she went hard on an outlying ridge of the Manacle rocks, off Lowlands Point, on the coast of Cornwall. The passengers were aroused and taken ashore in boats and aboard tugs which came up.

Following the disaster there was naturally much conjecture as to how it could have occurred. When she struck the *Paris* was within 150 yards of the shore and not half a mile from the spot where the Atlantic Transport liner *Mohegan* was wrecked on the night of October 14, 1898. Now, however, the real cause of the loss of the vessel has been made known by her late commander, Captain Frederick Watkins, in his report to the United States Board of Steamboat Inspectors at New York. Captain Watkins' report reads as follows:

I, Frederick Watkins, master of the American line steamship *Paris* of New York, of 10,669 tons register, make oath and say as follows: I was the master of the said steamship *Paris* when she left Southampton at noon of the 20th of May last with passengers, mails and general cargo, bound for New York via Cherbourg, and at 5.21 P. M. of the same day she arrived at Cherbourg. Having taken on board forty-five further passengers and their baggage, we sailed for New York at 5.52 P. M. At 6.38 P. M. Cape La Hague was abeam, and at 7.35 P. M. the Casquets Lighthouse was abeam. At 1.19 A. M. of the 21st of May land was suddenly seen ahead and reported. The helm was immediately put hard to starboard and the port engine was put full speed astern, but directly afterward the vessel struck on the rocks, which proved to be about a cable's length from the beach. It was then discovered to be thick over the land, although there was no fog to sea. St. Anthony's Light, which had not previously been seen, appeared bright and clear about fifteen minutes after the vessel struck. We reversed the engines full speed, but the vessel remained fast, and we then fired distress signals and swung out the boats. Assistance arrived and shortly after daylight the passengers, mails and baggage were sent ashore to Falmouth.

At daylight we ascertained the ship's position by cross bearings—St. Anthony's Light bearing N. E. by N., the buoy off the Manacles Rock E. by N. ¼ N. During the day the vessel began to make water in various compartments, and such water has increased until it is in every compartment. Practically the whole of the cargo was discharged, a large portion undamaged, and efforts by the underwriters and owners have been made at great expense to get the vessel off, but she is still on the rocks and is full of water fore and aft. No lives were lost or any personal injury caused by the accident.

I regret to say that the casualty was owing to an unaccountable error on my part. It is about 131 miles from Cape La Hague to the Lizard, and the run between these points would, I calculated, occupy six hours and fifty-four minutes. Unfortunately I reckoned the time on this basis for coming up with the Lizard from 7.35 P. M., when abeam of the Casquets, instead of from 6.38 P. M., when abeam of Cape La Hague, and the vessel was thus really eighteen miles ahead of the position I was acting upon. In addition the thick weather over the land had obscured the Lizard lights.

I attribute the stranding to the above cause and take upon myself full responsibility for it. I have followed the sea as my profession since the year 1851, and have held a British master's certificate since the year 1866 and an American master's certificate since the year 1893, in which year I became an American citizen. I entered the service of the Inman Steamship Company in the year 1863, and after serving as officer in various grades I was promoted to be master in 1867, and have since 1876 been continuously master in command in the Inman and International and American line passenger and mail steamers, and have in that capacity crossed the Atlantic nearly 500 times. I was, during the war between the United States and Spain, the navigating officer of the United States cruiser *Yale*, holding a commission as Commander in the United States Navy, and on the termination of the war I received honorable discharge with the thanks of the Government.

I have thought it right to place these particulars before you in the hope that you will take into consideration a long responsible seafaring career, during which I believe I have throughout held the perfect confidence of my employers. The accident was not due to any want of thought or anxiety about my vessel or her safety, but arose purely from the mistake I made in making my calculation above described. I should add that I can only speak in terms of the highest praise of the discipline which under trying circumstances was admirably sustained by my officers and crew.

After consideration of this report the Board of Inspectors, consisting of Peter C. Petrie and Thomas H. Barrett, decided to suspend Captain Watkins' license for a period of two years. Their finding reads:

We have the honor to report that we have carefully read over the report made by Capt. Watkins, late commander of the steamship *Paris* when she was stranded on the English coast, between the Lizard and the Manacles, on May 21, 1899, at about 1.19 A. M., in which Capt. Watkins takes the entire responsibility of the disaster upon himself in making a mistake in the time when he passed the Casquets and thereby overrunning his distance.

We find that the report is very meager in details, inasmuch as he merely states that he made a mistake in taking his departure from Cape La Hague at 7.38, when he was actually abreast of the Casquets at that time, a distance of about 16½ miles. This, of course, would put him 16½ miles ahead of his reckoning, but would not account for his being set in to the northward of his course some seven miles, allowing his intention pass the Lizard at a distance of three miles. As Capt. Watkins does not make any mention of making any allowance for tide, we are of the opinion that he had not taken that matter into consideration, whereas when he approached the English coast he must have encountered the flood tide on his port bow, setting him in toward the land. In addition to this he makes no mention of having used his lead, and he only discovers it was thick over the land when the ship is ashore.

Giving all due consideration to these matters, we are of the opinion that Capt. Watkins has not acted with the necessary care and attention requisite in the navigation of his vessel which a master should have used, and we therefore suspend his license as master of ocean steamers for a period of two years, as per authority conferred upon us by section 4,439 of the Revised Statutes of the United States.

A day or two after the passengers were landed a meeting was called, at which their thanks was expressed to the American Line for the courtesy and consideration with which they had been treated in these distressing circumstances. A number were given passage in the westbound German vessels, while others preferred to wait for the next outgoing American liner.

Following the mishap persistent efforts were made to get the *Paris* off the rocks, but it became apparent that extensive operations would be necessary if the vessel was to be saved. She was accordingly declared a total loss and abandoned to the Underwriters, who made an agreement with the salvors on the basis of "no cure, no pay." Systematic works was then begun, including the blasting away of the rock, and the floating of the great ship occurred rather unexpectedly. While an effort was

TWIN SCREW TRANSATLANTIC LINER PARIS SAILING UNDER THE HOUSEFLAG OF THE AMERICAN LINE—EMPLOYED AS AN AUXILIARY CRUISER (U. S. S. YALE) DURING THE SPANISH WAR.

being made to swing her stern around, so as to facilitate driving operations, she slid off the rocks into water sufficient to float her. Examinations showed that the holes in her bottom were not as extensive as had been supposed, and with the aid of the salvage pumps the vessel was easily kept afloat.

The *Paris,* as shown in the picture drawn by our artist, is a three-masted, three-funneled steamer, with a clipper bow. She is a twin-screw vessel, in dimensions: Length, 560 ft.; beam, 63.2 ft.; depth, 42 ft.; gross tonnage, 10,795 tons. She was built at Clydebank, Scotland, in 1888 to lower the Atlantic record, which she was successful in doing. Her 24 hours' record is 530 knots. The propelling engines are triple expansion, with cylinders 45 in., 71 in., and 113 in. dia., and 60 in. stroke, and at 90 revolutions they indicate 20,000 horse power. She has nine boilers, built for a working pressure of 150 lbs., and her

coal consumption is over 300 tons a day. She has accommodations for 540 first cabin and 200 second cabin passengers besides those in the steerage.

This is the second time in the history of the *Paris* that she has come safely out of threatened disaster. On her occurred what was undoubtedly the most disastrous machinery mishap in the history of transatlantic navigation. On March 25, 1890, while bound east, with about 1,000 passengers on board, the starboard tail shaft broke and the immense engines immediately raced and knocked themselves to pieces. The condenser connections at the side were torn away, and the engine room was immediately filled by the inrush of water. Flying fragments of the starboard engine had pierced the longitudinal bulkhead between the engine rooms, and the port engine compartment was in consequence filled also. There was a rough sea on at the time, and the big liner was tossed about helplessly. Three days later the steamship *Aldershot* was sighted, and took the *Paris* in tow for Queenstown, about 170 miles distant. There the sea connections on the starboard side were plugged, and the vessel, having been pumped out, proceeded under her own steam, with the port engines working, to Liverpool. The wreck of the engine was complete, or, in other words, a ten thousand horse-power engine was in scrap. The damage was estimated at $500,000, and a further sum of $37,500 was awarded the *Aldershot* for towage. Four years later the rudder of the *Paris* became disabled while on a westward trip, and she put back in Queenstown steering with the twin-screws.

The *Paris* was built for and operated by the Inman Line, and until that line was absorbed by the American corporation now known as the International Navigation Company, and more familiarly styled the American Line. She was admitted to American registry in 1893 by special act of Congress. The International Navigation Co. is now building several vessels, particulars of which are given on page 48 of this issue.

Mishaps to Naval Vessels.—Several serious mishaps on vessels of the torpedo-boat type have been reported recently from abroad. Early last month, while a destroyer built at a Sunderland yard was on trial, a steam pipe burst and eight men were more or less seriously scalded. An accident on H. M. torpedo-boat destroyer *Bullfinch*, which occurred on July 21, is reported by cable to have killed nine and injured four of those on board. The vessel was running in the Solent at high speed when a connecting rod in the starboard engine is said to have broken, and a smash-up of the engine followed. Live steam from the main pipe then filled the engine room. The *Bullfinch* is a 30-knot destroyer built by Earle's Shipbuilding Co., of Hull, England. She is a twin-screw vessel, fitted with engines of 5,800 I. H. P. and Yarrow boilers. Later another cable report was received here from Pola, Austria, briefly stating that "a boiler explosion" occurred on board the Austrian torpedo-boat *Adler* in the Adriatic Sea, killing a lieutenant and four of the crew. The *Adler* is one of the earlier first-class torpedo-boats, having been built by Yarrow, London, in 1885. She is a single-screw vessel, 135 ft. long, and has a displacement of 95 tons. Her indicated horse power is 900 and speed 22.4 knots.

CORRESPONDENCE DEPARTMENT.

Editor of Marine Engineering:

I quote the following from Mr. Leavenworth's explanation of Negative Slip, Marine Engineering for March, page 3:

"The question is then simply, under what circumstances might we expect an apparent slip of zero or negative value? Remembering the relation between these quantities as expressed in (2) it may be readily seen that this will be the case when the true slip is equal to or less than the wake."

Suppose that the true slip could be "less than wake." The velocity of the water sternward from the wheel cannot be greater than the true slip, and, therefore, if this slip be less than the wake we would have that portion of the wake that is sent sternward by the wheel going in reality forward with respect to the still water or the bottom, and we would have the remarkable result of the steamer making use of the water to *push* against and yet not pushing any sternward, but on the contrary, *pulling* water actually along with it.

It, of course, can be absolutely proved that water cannot leave the wheel with a velocity greater than the true slip, but it is so nearly self evident that unless it is disputed we will not take up your space with the proof.

Hence the true slip can never be "equal to or less than the wake," and the explanation given by Mr. Leavenworth only explains this "abstruse subject" by assuming an impossibility. G. B. Mitchell.

Reply.

In reply to Mr. Mitchell's observations I would say that the references to negative slip in the article referred to were based on the treatment more particularly presented to the engineering public by *S. W. Barnaby*, in the *Proceedings of the Institution of Civil Engineers (English)*, Vol. CII, p. 74, while that in turn was based on a paper by *R. E. Froude*, in the *Transactions of the Institute of Naval Architects*, Vol. XXX, p. 390. A complete discussion of the question would have been entirely out of place in the article to which Mr. Mitchell refers, and it is equally so here. A study of these papers will, however, perhaps serve to show the matter from another point of view.

Briefly, the very thing which Mr. Mitchell considers as a self-evident impossibility, that which is considered entirely unworthy of further notice, is the very thing which is considered as occurring. Mr. Mitchell states that it is well known and self-evident that the water cannot leave the propeller with a velocity greater than the true slip. By *velocity* presumably *acceleration* is intended, and it is with this point that Mr. Froude's paper has to deal. It is shown that in all ordinary propellers a part of the acceleration is produced forward of the blades by the action of a defect of pressure, a part while passing through between the blades, and a part aft of the blades by the action of an excess of pressure in the race. Probably thinking of the old and familiar proposition in text-books on hydraulics relating to the impulse of a jet of water on a vane, Mr. Mitchell considers only the acceleration produced at the propeller itself. This is, of course, less than the true slip of the propeller relative to the water through which it is passing, but the accelera-

tion produced at the propeller is in reality only a small part of the total amount. Of this amount somewhat more than one-half is produced forward of the propeller, a small amount in passing through between the blades, and the remainder aft of the propeller in the race. As Mr. Mitchell will find, on examination of the problem, the behavior of a propeller in a continuous and indefinite stream of water is very different from that of an ideal vane with a jet of water impinging upon it. In spite of all the study on the point, however, the complete solution to the problem of how much acceleration in any given case will be produced ahead of the wheel, how much in the wheel, how much aft, and how much altogether, has not been found, and until it has the complete examination of the question will be hardly possible in a satisfactory manner.

In my opinion, a very important influence is also rendered by the rounded backs of the blades, to which reference was likewise made in the same article referred to by Mr. Mitchell. This point was not further developed because complete experimental data does not exist on which to base a useful discussion. Enough does exist, however, to show that the influence of the back is such (particularly at small slips) as to increase the value of the acceleration, as resulting from the true propeller slip given by a measurement of pitch on the driving face. It is due to this influence that a positive thrust is obtained for a zero true slip measured from the driving face, as shown by diagrams 1 and 2 in the article referred to.

In the meantime science awaits a more comprehensive theory of the screw-propeller, and if Mr. Mitchell can furnish this he will do the cause of scientific marine engineering most valuable service; but for this end something is required beyond destructive criticism, and the erroneous assumption of "nearly self-evident" propositions.

EDMUND LEAVENWORTH.

American Shipbuilding Returns.

In advance of the publication of the annual report of the United States Commissioner of Navigation a summary covering the statistical portion of the report has been issued as follows:

The total output of American shipyards for the last fiscal year has been the largest of any year for the last quarter of a century, except 1891, when 1,384 vessels of 369,302 gross tons were built and documented in the United States. During the past fiscal year the construction of merchant vessels, officially returned, has consisted of 1,429 vessels of 320,876 tons. Besides these, twenty-two vessels of foreign construction, aggregating 30,181 gross tons, have been admitted to American registry, of which ten were prizes captured during the war with Spain; four were steamships, aggregating 12,126 tons, admitted by special acts of Congress, and the remainder wrecked vessels, repaired in American shipyards. It is also reported from Manila that since last August 141 vessels have been transferred from the hands of the Spanish, German and British subjects to Americans, indicating the confidence of the business men of Manila in the American Government. The tonnage of these vessels has not yet been reported, and the transfer does not carry with it all the rights of American registry. Had the Senate passed the House bill for the registry of Hawaiian vessels the total additions to our merchant fleet during the year would have reached nearly 400,000 tons. Our largest annual production was in 1855, when 2,027 vessels of 583,450 tons were built and documented.

During 1898 Great Britain built 1,549 vessels of 1,399,116 tons. The difference in the kind of vessels built is roughly disclosed by the average size, our construction averaging only about 225 tons, while the British averages 900 tons. Nearly all our new tonnage is built to navigate in the coasting trade reserved to American vessels. The only steamships built directly for the foreign trade were the *Havana* and *Mexico*, of the New York and Cuba Mail, and the four Admiral steamships for Cuba and Jamaica, aggregating 19,750 tons, which were built under the postal subsidy act. In anticipation of legislation at the coming session, however, construction has begun or been contracted for on about 100,000 tons of steel steamships for foreign trade and trade with Hawaii and Porto Rico, involving an expenditure of about $15,000,000.

For the first time in our history, on June 30 the total tonnage of our steam vessels, when tabulated, will exceed the total of all other kinds of documented vessels. During the year, however, 460 sailing vessels of 96,458 tons have been built, compared with 426 of 42,502 tons for the previous year, while the steam vessels built number 478 of 167,851 tons, compared with 448 of 110,128 tons for the previous year.

In certain trades our large sailing vessels endeavor to compete with foreign cargo steamships, and will doubtless continue to do so, at all events until the construction of the Nicaragua Canal. The most notable vessel is doubtless the *John Smoaton*, a steel schooner of 5,049 gross tons, built at West Superior, Wis., probably the largest fore-and-aft vessel ever built. The largest seagoing sailing vessel built in Europe in 1898 was the *Ernest Siegfried*, of Havre, 3,214 tons.

For the first time in our history, steel has become the principal material in our annual construction of rigged vessels, the steel tonnage for the year being 133,991 tons, wood 130,309 tons. Iron has ceased to be a ship-building material, only one vessel of nine tons having been built of iron. During 1898, in Great Britain, 99 per cent, or practically the whole construction except small fishing vessels, was of steel.

The additions to our sea-going fleet, including 30,181 tons foreign built referred to, were 166 vessels of 155,987 tons, divided into 50 steam vessels of 75,289 tons, 74 schooners of 62,906 tons, 10 square-rigged vessels of 12,428 tons, and 32 yachts of 5,364 tons, including the new cup defender. The square-rigged vessels are mainly for the foreign trade, and the schooners for coasting purposes or the trade with the British provinces and the West Indies. There were built 491 unrigged vessels, barges and canal-boats for Canadian or Interstate trade, aggregating 56,567 tons. Excluding these, the greatest increase has been on the Atlantic coast, the tonnage of rigged vessels built rising from 51,136 tons in 1898 to 134,352 tons for the past year, while on the Pacific there has been a decrease from 44,896 tons to 32,412 tons. The output of rigged vessels on the great lakes was 81,390 tons, compared with 45,211 during the fiscal year 1898.

EDUCATIONAL DEPARTMENT.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XIX.

BY WM. BAXTER, JR.

AMMETERS AND VOLTMETERS.

An ammeter is an instrument that is so constructed that it indicates the strength of the current that flows through it; that is, it indicates the number of amperes. A voltmeter is an instrument that indicates the e.mf. or electrical pressure of the current that flows through it; that is, it indicates the number of volts. Both types of instruments are constructed upon the same principles, and only differ from each other in the size of wire wound upon them. There are several ways in which these instruments can be made, but the most common arrangements depend upon the action of a permanent magnet upon an electric current, or upon the action of one current upon another, or upon the action of a current upon a mass of iron. The first type can be explained by the aid of Fig. 107. In this figure, *M* represents a permanent magnet. A permanent magnet is made of hardened steel, and is called permanent because it retains its magnetism. The letter *C* represents a coil of wire, through which the current to be measured is passed. This coil is mounted so as to swing freely, and with as little friction as possible. The indicator arm *B* is mounted central with the shaft upon which the coil is secured, and moves with it so that its position with reference to the scale *S* depends upon the position of coil *C*. When there is no current passing through the coil it has no tendency to rotate, but as soon as it is traversed by a current it becomes surrounded by magnetic lines of force, and these tend to set themselves in line with those of the magnet. The lines of force of the magnet run across from pole *P* to pole *N*, and the lines of the coil run parallel with its axis; that is, in the direction of arrow *d*. The lower side of the coil, therefore, tends to swing toward pole *N*. The motion of *C* is resisted by a spring, and sometimes by a weight, although the former arrangement is the best, and the only one that can be used with an instrument that is intended to act in any position. The force with which the coil is pulled around in the direction of arrow *a* will depend upon the strength of the current passing through it, and as the spring that resists its movement will offer a greater resistance the further it is twisted around, it follows that by properly proportioning the strength of the spring and the size of the

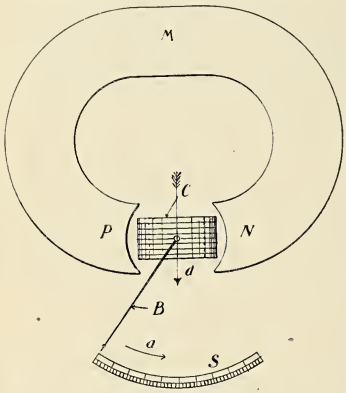

FIG 107.

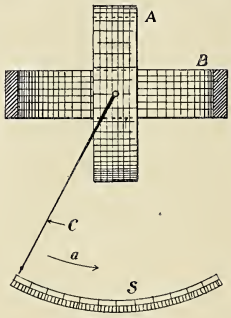

FIG. 108.

coil, the indicator can be made to move over the scale in a manner that is proportional to the strength of the current. If the instrument is to be an ammeter, and to indicate small currents, say from 50 amperes down to zero, then the resistance of the spring is made comparatively light, or the coil is provided with several turns, the result in either case being that the fifty amperes will twist the coil around until the indicator points to the end of the scale. The same instrument can be made to indicate 500 amperes by making the

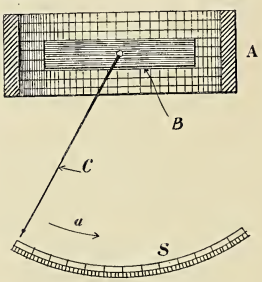

FIG. 109.

resisting spring ten times as strong, or by winding the coil with only one-tenth the number of turns. The last plan is that generally followed, as on account of the greater current it is necessary to increase the size of the wire so that it may not become too hot.

If an ammeter is intended to measure small currents, the whole current is passed through coil *C*, but when it is intended for currents of several hundred amperes, a shunt coil is provided and a definite portion of the

current is passed through coil *C*, the remainder passing through the shunt coil. The object of this is to avoid using large wire upon the movable part of the instrument, as it would then become necessary to provide substantial sliding contacts through which the current could pass to the coil, and the friction of these would render the instrument very torpid in its action.

When an ammeter is made with a shunt coil, the portion of the whole current that passes through the *C* coil is anywhere from 10 per cent down to a fraction of 1 per cent, the percentage decreasing as the capacity of the instrument is increased.

If an instrument is intended to be an ammeter, its coils are placed in series with the main line, and are, therefore, wound of comparatively large wire and a small number of turns. If the instrument is to be a voltmeter, it is connected in the circuit in parallel with the main line; that is, one end of its *C* coil is connected with one side of the line and the other with the other side. For example, if we desire to measure the voltage of the current delivered by a generator, we connect one terminal of the voltmeter to one of the brushes and the other terminal to the other brush. Under these conditions, the full force of the generator acts to drive a current through the voltmeter coil. Now, it is not permissible to send a strong current through the instrument, because all the current that passes through it is just so much energy lost, and, in addition, unless the instrument were made of very large size, it would become very hot. To avoid these difficulties, the coil of a voltmeter is made of very fine wire and consists of many thousand turns.

Fig. 108 shows the type of instruments in which the attraction between two currents is used to impart motion to the needle. In this arrangement there are two coils, *A* and *B*, set at right angles to each other. The coil *B* is stationary, and *A* is free to rotate, its movement in the direction of arrow *a* being produced by the action of the current, this movement being resisted by the tension of a spring, as in Fig. 107. The current to be measured passes through both the coils, and thus develops magnetic lines of force around each. These lines tend to place themselves in line, that is, parallel with each other; therefore, a twisting force is exerted upon coil *A*, and this force increases as the current strength increases.

As in the case of Fig. 107, the coil *A* can be made to move over its entire range with a weak or a strong current by simply proportioning the coils and the resisting spring properly in each case.

Fig. 109 illustrates the type of instruments in which the movement of the indicating arm is effected by the action of the lines of force developed by a coil upon a bar of iron placed within it. In this diagram *A* is the wire coil and *B* is the bar of soft iron. When there is no current passing through *A*, the bar *B* has no tendency to move, but when a current passes through *A*, a rotative force is at once developed, and *B* tends to move into a position parallel with the axis of the coil. If *B* is held directly at right angles to the axis of the coil, when there is no current flowing, upon the passage of a current it may start to swing around in either direction, as its only object is to get into a position parallel with the axis of the coil, regardless of which end goes up or down. To prevent this, all that is necessary is to set *B* with the left side a trifle lower than the right, then the swing will always be in the same direction. The case is like that of a crank that is placed upon the dead center; if we push against it, it is as likely to move in one direction as the other, but if the crank is slightly off the center, when we push against it, it can only move in one direction.

The bar *B* can be placed directly at right angles to the axis of the coil, providing it is made of steel and is hardened, but then it becomes a permanent magnet,

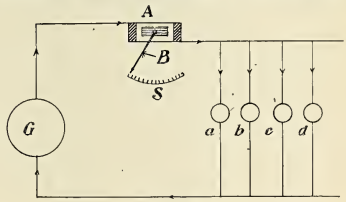

FIG. 110.

and the construction would simply be a modification of Fig. 107, in which the magnet would be placed within the coil instead of outside of it.

The movement of the bar *B* can be resisted by a spring, as in the previous types, or by a weight. With this construction the weight is quite commonly used, as then the bar can be arranged to swing with the greatest freedom. In the other arrangements in which a moving coil is used, it is necessary to provide means whereby the current may be conveyed to and from the coil without hindering its free movement, and the best way to do this is to use the springs, that oppose the movement, to carry the current. This can be accomplished by using springs of the clock type and placing one at each end of the shaft upon which the coil swings.

The difference between the action of an ammeter and a voltmeter can be explained clearly by means of the

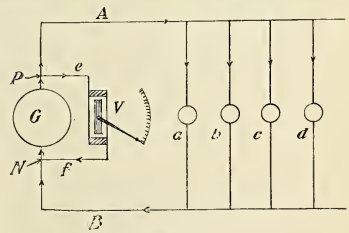

FIG. 111.

diagrams Figs. 110 and 111. The first illustrates an ammeter, and the second a voltmeter. In the first diagram, *A* represents the ammeter, and *G* represents a generator which furnished the current to operate the lamps *abcd*. As will be noticed, all the current delivered by the generator has to pass through the ammeter before it can reach the lamps; hence, if only one lamp is in use, the current passing through the instrument will be one-quarter as much as it would be if all the lamps were in operation.

In Fig. 111 *V* represents the voltmeter and *G* the generator, while *A* and *B* are the two sides of the main line, and *abcd* are the lamps. The current that passes through the voltmeter is diverted from the main line at the point *P* and returns to it at *N*, but these are the

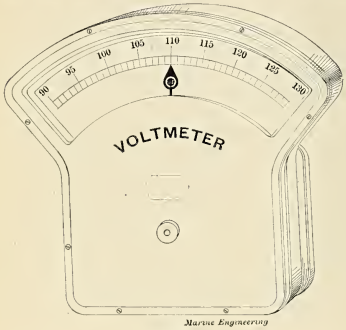

Fig. 112.

terminals of the generator. Now, so long as the pressure between the points *P* and *N* remains unchanged, just so long will the current passing through the voltmeter be constant, hence, as the pull will not change, the pointer will remain stationary. If the pressure, or difference of potential, as it is called, between *P* and *N* increases, the current passing through the voltmeter will increase, and the indicator will move further up, indicating a higher voltage, but if the difference of potential between *P* and *N* drops, the current passing through the voltmeter will reduce and the indicator will move downward, indicating a lower voltage. Since the strength of the current that passes through the voltmeter is directly proportional to the pressure between *P* and *N*, it follows that it is not influenced, in any way,

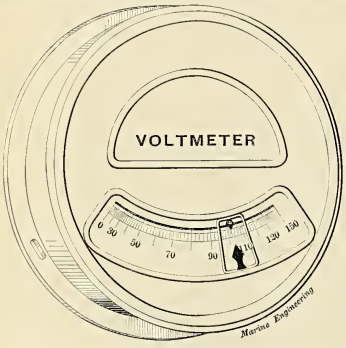

Fig. 114.

by the amount of current that passes to the line wires *A* and *B*, hence the instrument will measure the voltage only and will not be affected by the rise and fall of current strength in the main circuit.

From Figs. 112-114 the form of commercial instruments can be understood, but it may be mentioned that these are only two of many designs. Fig. 113 shows the manner in which the springs that resist the movement of the coil are arranged in the instrument shown in Fig. 112. This illustration shows the instrument with a portion broken away so as to give a full view of the interior. The drum seen in the center is a core made of soft iron, and upon this is mounted the coil which can be seen with its side running parallel with the axis of the core. The spiral springs at top and bottom not only resist the movement of the drum and its coil, but also serve to form the connection

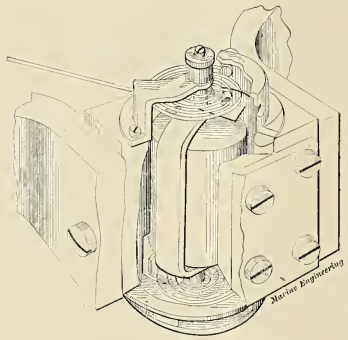

Fig. 113.

between the ends of the coil and the stationary parts of the instrument; thus the current is conveyed to and from the coil without introducing the friction of sliding contacts.

S. S. Chester W. Chapin.—At the yard of the Marylany Steel Company, Sparrow's Point, Md., the fine new steamboat *Chester W. Chapin*, for the New Haven Steamboat Company, was launched July 11. The new vessel will be practically a duplicate of the famous Sound steamer *Richard Peck*, but will have rather more cabin accommodation than that vessel. Her dimensions are: Length, l. w. l., 310 ft.; breadth, over guards, 64 ft.; depth, 17 ft. 2 in. She will have twin screws, driven by triple expansion engines, with cylinders 24 in., 38 in. and 60 in. dia., and 30 in. stroke. These will be furnished with steam by six Scotch boilers, 13 ft. dia. and 11 1-2 ft. long, built for 160 lbs. working pressure. A speed of about 21 miles an hour is looked for. The new vessel will be equipped with every modern device for the comfort and safety of the passengers. Special trains conveyed guests from New York, Philadelphia, Wilmington and Baltimore to Sparrow's Point, where they were hospitably entertained by the Maryland Steel Company. The little daughter of Superintendent D. A. Geraty, of the steamboat company, christened the vessel, which slid into the water with remarkable ease. After the launch the visitors spent some time looking over the marine department of the immense plant of the builders, and they carried away many favorable impressions. Other work in the yard includes two large freight steamers and three torpedo-boat destroyers.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—We would like to get your opinion upon a method of propulsion which we have tried. We built a boat 70 ft. long and of about 25 tons burden as an experiment. Our wheels are of different construction from the ordinary propeller. They are made of bronze, with two or more blades, and are applicable to either bow or stern without changing the forms. We run on one shaft, which pierces the boat from stem to stern. Running the stern wheel by itself we easily make, say 10 miles per hour, and this is the case with the bow wheel, also running alone. But when we combine both together our speed is only very slightly increased—why is it that when they are operated together we do not get a marked increase of speed? We lately tried a special wheel of the usual form, 38 in. dia., at the stern in conjunction with our own 22 in. wheel at the bow, but got only about the same result. What is your opinion of the value of such a wheel at the bow? Our boat handles beautifully with either of the new wheels, backing or going ahead with equal facility, and in backing it seems to exert a force far in excess of the old method.

C. H. A.

A.—Without more definite information regarding the details of your arrangement and the results of your trials, it is impossible to give any extended discussion of the questions you ask. In the first place, however, you should remember that it is the engine and boiler which really drive your boat, and not the propeller. The latter is merely an agent in applying the power developed by the former. Now, it is quite possible that either of your propellers singly is sufficient to absorb and apply the power developed by your engine and boiler, while both together can do no more; so that you get about the same speed whether you have one or the other, or both, the only differences being those due to the differences in the efficiency of the arrangement; or in other words, in the fraction of the total power developed which is usefully applied. Again, supposing even that the engine and boiler are capable of supplying the full power required for the two propellers working at the same efficiency as the one alone. Then twice the power will be applied. This, however, will by no means give twice the speed. If the speed with one propeller was 10 miles, the speed with two would not be 20 miles, but only about 12.5 miles. This is because the speed increases by no means as fast as the power, but rather about as the cube root of the power. To get a speed of say, 16 miles, which you may perhaps have felt like expecting, would require about four times the power that 10 miles would, and it is very certain that your wheels could not efficiently absorb this, even if the engine and boiler could furnish it.

In regard to the general proposition of fitting a propeller at the bow, it may be said that hitherto such attempts have been failures from the economic standpoint. The speed developed with the same power has always been less with the propeller at the bow than at the stern. The reason is chiefly that the water set in motion by the propeller is driven aft against and along the bow, thereby greatly increasing the resistance to motion. It may be argued that a propeller at the stern acts like a pump and pulls the water away from about the ship, thus also increasing the resistance to motion, and that hence the two propellers are similar in this respect. This is true as far as it goes, but the propeller at the stern has an offsetting advantage not possessed by the one at the bow. It acts in the following current or wake of water set in motion by the ship, and is thus enabled to get from the water a return of a part of the power expended in driving the ship. In short, the loss due to the increase of resistance which comes from the action of the propeller at the stern is practically just about made up by the gain due to the location of the propeller in the following wake. With the propeller at the bow this is not the case, and hence it is at a relative disadvantage, and so far as experience has yet shown, it cannot compete with a propeller at the stern as an economical mode of ship propulsion. The same is true of the combination of two propellers, one at the bow and the other at the stern. Experience has thus far shown the combination to be less economical than a propeller properly designed to absorb the whole power and located at the stern.

If your propeller is as efficient as you believe, it would probably do better to locate one of proper size at the stern rather than to divide it up between two, one at the bow and the other at the stern, as you have done.

Q.—Following is a copy of a sum I got at an examination. Will you kindly work it out for me? What is the H. P. of a compound engine 20 in. and 38 in. by 30 in., steam 113 lbs., revolutions 116, H. P. cylinder cutting off at 3-4 stroke, vacuum supposed to be perfect? Also please say if Grey's method of finding the mean pressure of steam is all right for a H. P. cylinder, as he makes no mention of back pressure. SUBSCRIBER.

A.—In an example like this the power must be figured as though it were all developed in the L. P. cylinder, using the initial steam pressure and the total number of expansions from cut-off in the H. P. to the end of the L. P. In the H. P. cylinder, neglecting the effect of clearance (as we must since no mention of it is made), the cut-off at 3-4 stroke will give 1 1-3 expansion to the end of the stroke. Then this same steam finally fills the L. P. volume, and hence is expanded as many more times as the H. P. volume is contained in the L. P. This ratio will be the same as that between the areas. From a table of areas of circles we find:

Area of 20-inch circle = 314.16.
Area of 38-inch circle = 1134.12.
Ratio = 1134.12 ÷ 314.16 = 3.601.

Hence the steam is expanded 1.333 times in the H. P. cylinder and 3.601 in going from the high to the low. The total expansion ratio is therefore the product of these two, or $1.33 \times 3.6 = 4.8$. We then assume perfect expansion without loss and without back pressure, and find the *mean pressure* by the formula—

$$p_m = p\left(\frac{1 + hyp.\ log.\ r}{r}\right)$$

where p is the absolute pressure at the engine and r is the expansion ratio. You state the pressure to be 113 lb., and if this is taken as *gauge* pressure, then the absolute pressure will be greater than this by the pressure of the atmosphere. Taking this at 15 lb., we have $p = 113 + 15 = 128$. From a table of hyperbolic logarithms we find hyp. log. $4.8 = 1.5686$.

Hence $p_m = 128\ \ (2.5686 \div 4.8) = 128 \times .535 = 68.5$. We take next the horse power formula

$$I.\ H.\ P. = 2\ \frac{P\ L\ A\ N}{33{,}000}$$

in which we have:

$P = 68.5$
$L = 2.5$
$A = 1134$
$N = 116$

Substituting and reducing we find $I.\ H.\ P. = 1365$, the value of the indicated horse power on the basis assumed.

In any actual case there would be, say, 3 lb. back pressure, and the mean forward pressure realized would not be over .75 or .80 of the ideal obtained as by the rule above. This would give, say, 50 lb. as a probable mean pressure in an actual engine working under the conditions and with the steam pressure as stated. Using 50 lb. instead of 68.5 lb. in the horse power formula as above, we find 966 for the horse power, or say 1,000 for a round number.

McFarlane Gray's rule cannot be used for the H. P. cylinder. It gives the mean pressure supposing the vacuum perfect, or no back pressure, the same as the rule used here. In fact, Gray's rule is simply an approximate method of working out the value of $(1 + hyp.\ log.\ r) \div r$.

NEW PUBLICATIONS.

THE NAVAL ANNUAL, 1899. By T. A. Brassey. Thirteenth year. New York, D. Van Nostrand Company, 23 Murray St. Size, 6 1-2 by 10. Pages, 480. With engravings, charts and plans, cloth, $6.00.

This work has come to fill a place entirely its own in the periodical naval literature. Throughout the world it is naturally consulted as a complete and comprehensive digest of the year's naval affairs, with, of course, special reference to the British fleet and its equipment. The present volume seems well up to the standard set by those which have preceded. In the preparation of the matter on foreign navies the editor notes with regret the absence of the assistance of M. Weyl, who in recent years has furnished the matter for this chapter. On the other hand there are several special features, including a special chapter on the U. S. Navy, by Lieut. Com. W. H. Beehler, U. S. N., and a chapter on the naval aspects of the late Spanish-American war, by Col. Sir George Clarke.

Lord Brassey furnishes an introduction on the state of the British Navy, written in Australia at the close of 1898. The subjects of manning the navy and the naval reserves are considered, and especial reference is made to the movement for a colonial naval reserve, and to the conditions under which the colonies and the mother country may unite on a practicable scheme. The recent types of war ships are noted and compared with those of foreign powers, the natural conclusion being reached that both in battleships and cruisers the English types are on the whole superior to those of other nations. The comparative strength of navies, the destruction and protection of commerce, the decay of the Triple Alliance, and the growth of British sentiment and of friendship with the United States, are also touched on in the interesting and instructive style of the writer.

Chapter I on the British Navy, by the editor, gives a well condensed account of the progress during the past year. Due to the exigencies of engineers' strikes and other circumstances, it appears that no battleships were completed during the year, though sixteen were under construction or projected. Of these six are of the *Canopus* class, six of the *Formidable* class, and four of the *Duncan* class not laid down at the time of writing. The work on the various classes of cruisers is also noted and the trial results in several cases are given. The characteristics of the *Cressy* and *Drake* classes and other new designs are noted and compared with those of the *Diadem* class. The points of advance over the latter consist chiefly in an armored belt and in a main battery of two guns of 9.2 inches caliber supported by 6 inch guns, instead of a battery of 6 inch guns alone. The "destroyer" fleet is also discussed, and the recent types are described.

In Chapter II a résumé is given of the year's work in navies other than those of Great Britain and the United States, to the latter of which a special chapter is also devoted. The French, Russian, Italian and German navies naturally receive chief notice, though special note is made of the rapidity with which Japan has within a few years advanced to a naval position demanding serious consideration, and brief descriptions are given of the more notable additions to her fleet.

In Chapter III the question of comparative strength is discussed from a variety of standpoints. The squadrons in commission on the various stations are first compared, but without any attempt to equate ships of different classes. Following this is placed a general comparative résumé of the entire fleets of *Great Britain, France, Russia, Italy, Germany,* the *United States* and *Japan,* the two latter being included in the résumé for the first time. The question of comparative strength is also discussed particularly with reference to the relations of Great Britain to the other European powers, either singly or in combination. This is followed by comparative tables for each type of ship for the different countries, giving in parallel columns for convenience of comparison, the name, date, and displacement. According to these tables and the classification adopted, the U. S. fleet consists of 12 first class battleships, 1 third class battleship, 10 coast-guard and harbor-defense ships, 4 first class cruisers, 11 second class cruisers, and 5 third class cruisers. In the table of gunboats the United States, apparently by oversight, is credited with none instead of the 17 borne on her lists, without counting those recently added from the Spanish navy. In the tables of data following at a later point and giving the more complete showing of vessels for each nation under its own heading, this oversight is corrected, the gunboats appearing as they should.

In Chapter IV is given a comprehensive sketch of the recent development and present condition of the U. S. Navy. The MS. for this chapter seems to have been furnished previous to the passage by the last Congress of the "personnel" bill, so that in reference to this subject the former status is described with a brief reference to this bill, the provisions of which were also briefly referred to in the preceding number of this *Annual.* The various types of ships constituting the U. S. Navy are described in detail, and the leading points in the most recent designs are especially considered. One item of note is the fitting of bilge keels on the destroyers, such step having been taken as a result of experience under cruising conditions in such boats, in which the excessive and lively rolling is found to wear seriously on the crews. The elimination of wood or the substitution of fireproofed wood in all designs is also noted. The recent development of U. S. Naval Ordnance is also discussed, and especial note is made of the new designs for 4, 5, 6 and 8 inch guns of 40 to 50 calibers length.

In Chapter V Col. Sir George Clarke discusses the naval aspects of the Spanish-American war. The causes leading up to the war are summarized and a general comparison is made between the naval and military forces of the two nations. Special note is made of the paralyzing influence on the movement of some of our ships due to fears on the North Atlantic seaboard of a possible descent upon coast cities—fears which by naval officers were probably always considered as absurd to the last degree, and yet commanding sufficient influence to seriously interfere with the freedom of ships for offensive movements on the part of our naval forces. It may be hoped that, at least after

the event, the over timid residents of New England and other cities may be able to recognize how utterly unreasonable and uncalled for were their fears and demands. The battle of Manila Harbor is then briefly considered and the results are discussed. Next taking up the course of events on the Atlantic beginning on the other side with the formation of Cervera's squadron and on this side with the formation of the so-called flying squadron and the bombardment by Admiral Sampson of San Juan and ending with the naval battle of Santiago, the series of movements are given in detail and with much interesting discussion of the questions of tactics involved. Doubt is expressed of the justification for the bombardment of San Juan, a doubt which is perhaps not new to many on this side of the Atlantic. The game of hide and seek between Admiral Cervera's ships, the two U. S. squadrons, the squadron of scouts and the cable is followed through as it can be now when all is known, and the final victory for the cable and the apparent ineffectiveness of the big and fast scouts is noted. The author points out that while the facts could not, perhaps, have been known at that time, present information would seem to show that there should have been no difficulty in sailing east to meet Cervera's squadron and in keeping in touch with them from the time when picked up, and in thus fulfilling the purpose of scouting in the larger sense. In the actual fact the performance as scouts of these large and fast ships was disappointing, but it is perhaps yet too soon to attempt to assign in detail the causes, and perhaps sufficient allowance is not made for the needle in a hay stack hunt which such a mission involves. The operations of cable cutting are also referred to, and in this connection an error is made which should not go uncorrected. On page 166 it is stated that "On May 11 two steam and two sailing launches from the *Marblehead* and *Nashville* were employed in an attempt to cut the cables off Cienfuegos. Two cables were discovered, but could not be cut under the rifle fire from the shore, which caused nine casualties." All accounts of this operation report the attempt as entirely successful, and in Lieut. Winslow's personal narrative published in the *Century* for March, 1899, the affair is described in detail. From this narrative it appears that 150 feet were removed from the Santiago cable and 100 feet from the Batabano cable, while the number of casualties were two killed, six severely and one slightly wounded. One of the important lessons drawn from the war is the influence which the pernicious activity of the modern sensational press and the politician may have on the conduct of a campaign. This the author summarizes in the following words:

> In April, 1898, the naval authorities had a plan of operations carefully matured. The press and the politician supervened, with the natural result that the plan disappeared, and the initial naval proceedings took the form of a compromise strategically indefensible. The incompetence of the Spanish Navy was so complete that this sacrifice of principles to popular clamor proved quite unimportant. In less fortunate circumstances it might have been disastrous. War, whether by sea or land, is a game that can be effectively played only by experts acting in accordance with great principles. In free countries, where the views of sailors and of soldiers are always liable to be regarded with suspicion, there is a real danger that the direction of warlike operations may be warped by an uninstructed popular outcry. This, to the United States and to ourselves, is perhaps the greatest lesson of the recent war.

In Chapter VI a more detailed comparison is made between representative ships of the leading naval powers in the battleship and cruiser types. Details of the ships and of their armament, are given, and comparisons are made of the gun fire per ton of displacement. What curious things figures may be made to prove is well illustrated in the treatment of the new U. S. S. *Maine* now building. The armament is given correctly, but in calculating the energy of gun fire the energy per gun is taken from the 12 inch guns now afloat, and for the old type of 6 inch guns, while for the ships of all the other nations the computations are based on the latest designs. This would give for the *Maine* an energy of 30.3 ft. tons per ton of displacement, which by a further numerical error is reduced to 22.32, the others ranging from about 35 to 52. In a foot-note, however, it is stated that should the *Maine* receive guns equal to those of modern English design, the total energy per ton displacement would be 44.8, a figure comparing favorably with those of other navies. It is perfectly safe to say that the *Maine* will have ordnance of the new U. S. naval design, and certainly not notably inferior to that of other nations, so the assumption of a gun fire energy 30 per cent. lower for the same guns than for other navies seems quite unnecessarily unfair. If in addition the full designed muzzle velocity of 3,000 f. s. should be assumed, the total energy would be raised to 656,000 ft. tons, thus heading the list, and giving a value of 52.5 ft. tons per ton of displacement. In a similar comparison between ships of the cruiser class the United States is omitted, and rightly, since we have had no recent designs of this class.

In Chapters VII, VIII and IX are discussed respectively the question of British coast fortifications, the operations of the Nile gunboats in the Soudan campaign, and the French and German naval maneuvers of the year.

In Chapter X the advances in marine engineering are briefly discussed by G. R. Dunell. The voyage of the *Oregon* is mentioned as showing how much may depend on the efficiency of the engineer's force, and a word is spoken in behalf of this tardily recognized part of the ship's complement as a factor of the very highest importance in the value of a war ship from the fighting standpoint. The rapid advances of the water-tube boiler toward general adoption for naval purposes, and especially the declaration in its favor by Admiral Melville, are noted as perhaps the most significant indications of the year. The difficulties attending the attainment of high economy by naval engines, triple versus twin screws, the growing importance of balancing engines, the advances made with nickel steel for shafting and for plates, and the Parsons steam turbine as a motive power for destroyers, are among the other topics discussed in this chapter, which closes Part I.

In Part II are given the usual alphabetical lists of ships of all navies, with their chief particulars. It is these lists which give to the *Annual* one of its chief values, and the present issue follows the lines of its predecessors, and is apparently up to its accustomed high standard of accuracy and completeness. In the

U. S. list are included the principal auxiliary cruisers enrolled during the Spanish-American war. Accompanying these lists are the usual illustrations showing the distribution of the armament, offensive and defensive, of the leading type ships of the various navies. Many of these plates are new and full page, adding much to the pictorial value of the book.

In Part III a special discussion is given of the advances in ordnance and armor during the year, and the usual tables of British and foreign ordnance are given. In the U. S. tables the new designs are entirely lacking, an omission which may perhaps explain the low energy given to the battery of the *Maine* as referred to in the foregoing. In the development of armor the advance of the Krupp process is the feature of principal importance. Accompanying this are found also tendencies toward a reduction in the thickness of the belt, and a large increase in the amount of side covered by the armor, such changes being peculiarly favored by the increase in the resisting power given by the Krupp plates. The latest typical arrangement according to these ideas involves the fitting of a belt not exceeding 9 or 10 inches in thickness, and above this covering practically all of the side, or at least all behind which guns are placed, with plate of about 6 inches thickness. In discussing the problems connected with the modern naval gun, the difficulties attending the use of cordite and other smokeless powders are emphasized, especially the scoring of the tube and the falling off in service of the velocities attained on test trials. The rapidly increasing amount of powder required for increasing velocities is also noted, and the opinion is given on the authority of Captain Honner, R.N., that a service velocity of about 2,500 f.s. is the highest practicable under present conditions. This opinion is of interest in connection with the new U. S. designs which are expected to give 3,000 f.s.

Taken as a whole the present issue of the *Annual* seems to justify the high expectations which its predecessors warrant us in forming, and while in such a mass of statistical matters errors of the character mentioned here are almost impossible to entirely avoid, the only wonder is that they are not more numerous or more serious in character.

Italy and Her Position as a Naval and Military Power. By Cristoforo Manfredi. Enrico Voghera, Rome. Size 5 1-2 by 8 1-2. Pages 73. With numerous vignettes.

This pamphlet is a reproduction or second edition of a series of papers published first in 1892. Its purpose is to arouse the Government and people of Italy to a realizing sense of their situation—as seen with the author's eyes—and to aid in the general agitation of questions of national defence and growth, as viewed from the standpoints of modern political, military and naval science. Especial stress is laid on the "struggle for prosperity" as the one controlling feature of the modern political situation, and France and England are noted as the chief rivals whose operations may be expected to interfere with those of Italy. The author claims for the land frontier, especially between France and Italy, that the latter, aided by the natural defences furnished by the Alps, is in a position to repel any army of invasion likely to be brought against it. The same is, however, far from true relative to the navy as the protector of the coast frontier, and based on this proposition a powerful plea is made for the upbuilding and strengthening of the navy as a means of coast defence. The author points out also that surrounded as Italy is on the land, and fixed as are now the general geographical boundaries of the powers of Europe, the only way open for expansion is by the sea, and to utilize this pathway a navy is needed which shall follow the Italian with the protection of his flag, and which shall be able to protect his interests whenever and however they may be imperiled. In the concluding chapter is given an interesting discussion of the political equilibrium in the Mediterranean, and a final and strong appeal is made for a navy which shall be as efficient a protector for the coasts of Italy as are the Alps and their forts for the land frontier. The author is very much in earnest with his subject, and writes with great vigor. His pages abound in familiar truths, forcefully put, and often in a new light. The pamphlet should do its part in calling the attention of the Italian people to these questions of national growth and defence, though perhaps the ideal of the author is yet a long way off.

Increasing interest in the merchant marine and the navy which has followed upon the war with Spain has given an impetus to publications of the character of the "Blue Book," just issued from the press. This book, which the publishers claim is the only marine and naval directory of the United States, is this year more handsomely illustrated than ever, and is put out in a more convenient form. It is not only a book of reference for the ship-builder, ship-owner and naval architect, and the merchants and manufacturers who have dealings with these interests, but it contains also a hundred or more pages devoted to statistics of water commerce and to general information regarding the merchant marine and navy. Among noteworthy features incorporated in the 1899 edition is a comprehensive history of the year in everything pertaining to the construction and navigation of vessels. The directory part of this publication contains particulars of American steam and sail vessels, with names and addresses of owners, separated as to coasts, Western rivers and Great Lakes; lists of shipowners, ship and engine builders, naval architects, marine engineers, vessel masters, and members of various organizations made up from the navy and merchant marine; particulars of vessels of the United States Navy; heads of government bureaus in the United States and Canada connected with shipping; steamship lines, including those operating to foreign ports, with details of service, principal offices and names and addresses of managers. The Blue Book is published by The Marine Review Publishing Co., Cleveland, Ohio, and will be forwarded to any address upon receipt of $5.

The steam yacht *Fra Diavolo* was sunk in the North River, New York, by one of the Merritt & Chapman Company's tugs July 7 last. There were ten passengers on the yacht, and the crew numbered several men. All were taken off in safety before the vessel sank. The cause of the collision was said to be due to a mistake in signals. The *Fra Diavolo* was a wooden, single screw, schooner rigged yacht, in length 107 ft., and of 64 tons gross tonnage. She was built at Tottenville, S. I., in 1880 for E. S. Stokes, of New York.